PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2004-037925

(43)Date of publication of application : 05.02.2004

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(51)Int.Cl. G02B 15/20
G02B 13/18
G02B 15/16
G03B 11/00
H04N 5/225
// H04N101:00

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(54) IMAGING APPARATUS

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a compact imaging apparatus provided with a high performance and high magnifying power zoom lens system.
SOLUTION: The imaging apparatus is provided with a zoom lens system having a plurality of lens groups for continuously optically forming the optical image of an object so as to vary power by changing intervals between a plurality of the lens group and an

imaging device for converting the optical image formed by the zoom lens system to electric signals. The zoom lens system is provided with a first lens group having negative power as a whole and having a reflection surface for bending a luminous flux for about 90° and a second lens group arranged with a changeable air interval from the first lens group and having power in the order from an object side. The first lens group is composed of a negative lens element having the negative power and the reflection surface in the order from the object side.

LEGAL STATUS [Date of request for examination] 17.09.2004
[Date of sending the examiner's decision of rejection]
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]
[Date of final disposal for application]
[Patent number]
[Date of registration]
[Number of appeal against examiner's decision of rejection]
[Date of requesting appeal against examiner's decision of rejection]
[Date of extinction of right]

* NOTICES *

CLAIMS

[Claim(s)]

[Claim 1]

It is image pick-up equipment equipped with the image sensor which changes into an electrical signal the optical image which the zoom lens system which forms an objective optical image possible [variable power] optically continuously, and the zoom lens system formed by having two or more lens groups and changing spacing of this plurality lens between groups,

Said zoom lens system is in the order from a body side,

The 1st lens group including the reflector which has negative power as a whole and bends the flux of light 90 degrees of abbreviation,

Air spacing which can change between said 1st lens groups is separated, it is arranged, and the 2nd lens group which has power is included,

the negative lens component for which said 1st lens group has negative power sequentially from a body side, and a reflector -- since -- the image pick-up equipment characterized by becoming.

[Claim 2]

Image pick-up equipment according to claim 1 characterized by the 1st lens group of said zoom lens system consisting of the 1st lens element which has negative power, and a reflector sequentially from a body side.

[Claim 3]

Image pick-up equipment according to claim 1 to 3 with which the 1st lens group of said zoom lens system is characterized by being fixed to the image surface on the occasion of variable power.

[Claim 4]

Image pick-up equipment according to claim 1 to 3 most characterized by the field by the side of an image, and arranging [of said zoom lens system] the optical low pass filter between said image sensors.

[Claim 5]

The digital camera equipped with claim 1 thru/or one image pick-up equipment of 4.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs]

This invention The optical image formed on light-receiving sides, such as CCD (Charge Coupled Device charge-coupled device) and a CMOS sensor (Complementary Metal-oxide Semiconductor complementary metal oxide semiconductor sensor) It is related with image pick-up equipment equipped with the image sensor changed into an electrical signal. Especially, a digital camera; it is related with a personal computer, a mobile computer, a cellular phone, an information personal digital assistant (PDA:Personal Digital Assistance), etc. at the image pick-up equipment which is the main component of built-in or the camera by which external is carried out. It is related with small image pick-up equipment equipped with the zoom lens system especially in detail.

[0002]

[Description of the Prior Art]

In recent years, image sensors, such as CCD and a CMOS sensor, are used instead of a silver halide film, an optical image is changed into an electrical signal, and the digital camera which digitizes, records or transmits the data is spreading quickly. In such a digital camera, in order to offer comparatively

cheaply CCD which has high pixels, such as 2 million pixels and 3 million pixels, and a CMOS sensor recently, it is anxious for the compact image pick-up equipment with which the need over the highly efficient image pick-up equipment equipped with an image sensor is growing very much and which carried the zoom lens system in which variable power is possible, without getting down and degrading image quality especially.

[0003]

Furthermore, in recent years, by improvement in image-processing capacity, such as a semiconductor device, external is carried out and image pick-up equipment is accelerating the personal computer, the mobile computer, the cellular phone, the information personal digital assistant (PDA:Personal Digital Assistance), etc. at built-in or the need over highly efficient image pick-up equipment.

[0004]

Many zoom lens systems of the so-called negative lead in which the lens group arranged most at the body side has negative power as a zoom lens system used for such image pick-up equipment are proposed. Wide-angle-izing is easy for the zoom lens system of a negative lead, and it has the description of being easy to

secure the lens back required for insertion of an optical low pass filter.

[0005]

As a zoom lens system of a negative lead, there is a zoom lens system proposed as a taking-lens system of the camera for silver halide films from the former. However, since the exit pupil location of the lens system in the shortest focal distance condition was comparatively located near the image surface, especially these zoom lens systems did not have consistency with the pupil of the micro lens prepared corresponding to each pixel of the image sensor which has especially a high pixel, but had the problem that the amount of ambient light could not fully secure. Moreover, since an exit pupil location was sharply changed at the time of variable power, the problem of being difficult also had a setup of the pupil of a micro lens. Moreover, primarily, with a silver halide film and an image sensor, since optical-character ability, such as spatial frequency characteristics called for, completely differed, sufficient optical-character ability required of an image sensor was not securable. For this reason, it will be necessary to develop the zoom lens system of the dedication optimized by image pick-up equipment equipped with the image sensor.

[0006]

On the other hand, since image pick-up equipment is miniaturized, the zoom lens system was bent in the middle of the optical path, and drawing or ****** has accomplished miniaturization, without changing the optical path length. For example, in the zoom lens system of a negative lead, after establishing a reflector on an optical path and bending 90 degrees of abbreviation, the image pick-up equipment which forms an optical image on an image sensor through a migration lens group is proposed by JP,11-196303,A. After the image pick-up equipment of this official report indication establishes a reflector in the image side of the fixed lens element of a negative meniscus configuration and bends an optical path 90 degrees of abbreviation in this reflector, it has the configuration which results in an image sensor through two movable positive lens groups and the positive lens group of immobilization.

[0007]

Moreover, as another example, after establishing a reflector in the fixed lens element [of a negative meniscus configuration], and image side of a movable positive lens group and bending an optical path 90 degrees of abbreviation in this reflector, the configuration which results in an image sensor through a positive lens group is indicated by JP,11-258678,A.

[0008]

[Problem(s) to be Solved by the Invention]

However, in the two above-mentioned official reports, only the configuration of a camera cone was indicated but there was a problem that the configuration of a concrete zoom lens system was unknown. Unless the zoom lens system which occupies the biggest space in volume with image pick-up equipment equipped with the zoom lens system is optimized, it is difficult to attain the whole miniaturization.

[0009]

This invention aims at offering compact image pick-up equipment, it being highly efficient and having a high scale-factor zoom lens system in view of the above technical problem.

[0010]

[Means for Solving the Problem]

In order to solve the above-mentioned technical problem, the image pick-up equipment concerning this invention The zoom lens system which forms an objective optical image possible [variable power] optically continuously by having two or more lens groups and changing spacing of this plurality lens

between groups, It is image pick-up equipment equipped with the image sensor which changes into an electrical signal the optical image which the zoom lens system formed. Said zoom lens system The 1st lens group including the reflector which has negative power as a whole in order from a body side, and bends the flux of light 90 degrees of abbreviation, the negative lens component for which said 1st lens group has negative power sequentially from a body side including the 2nd lens group which separates air spacing which can change between said 1st lens groups, is arranged, and has power, and a reflector -- since -- it is characterized by becoming.

[0011]

Moreover, another side face of this invention is characterized by being a digital camera containing the above-mentioned image pick-up equipment. In addition, conventionally, although the word of a digital camera had pointed out what records an optical still picture chiefly, the thing and the digital camcorder for home use which can treat an animation to coincidence are also proposed, and it is not distinguished especially now and is becoming. Therefore, the word of a digital camera shall contain hereafter all the cameras that use as a main component image pick-up equipment equipped with the image sensor which

changes into an electrical signal the optical image formed on the light-receiving side of image sensors, such as a digital still camera and a digital movie.

[0012]

[Embodiment of the Invention]

Hereafter, 1 operation gestalt of this invention is explained with reference to a drawing.

[0013]

as shown in drawing 19 , the image pick-up equipment which is 1 operation gestalt of this invention comes out sequentially from a body side (photographic subject side) with the image sensor SR which changes into an electric signal the optical image formed of the zoom lens system which forms an objective optical image possible [variable power], and TL, the optical low pass filter LPF and the zoom lens system TL, and is constituted. Moreover, the zoom lens system contains the 1st lens group Gr1 which has the prism PR which has a reflector inside, and the lens group which follows. Image pick-up equipment is the main component of built-in or the camera by which external is carried out at a digital camera; video camera; personal computer, a mobile computer, a cellular phone, an information personal digital assistant (PDA:Personal Digital Assistance), etc.

[0014]

The zoom lens system TL consists of two or more lens groups containing the 1st lens group Gr1, and it is possible by changing spacing between each lens group to change the magnitude of an optical image. The 1st lens group Gr1 has negative power, and has the prism PR which bends the optical axis of body light 90 degrees of abbreviation inside.

[0015]

The optical low pass filter LPF has the specific cut-off frequency for canceling the color moire which adjusts the spatial frequency characteristics of a taking-lens system, and is generated with an image sensor. The optical low pass filter of an operation gestalt is a birefringence mold low pass filter created by carrying out the laminating of the wavelength plate to which birefringence ingredients and plane of polarization, such as Xtal adjusted in the predetermined direction in the crystallographic axis, are changed. In addition, the phase mold low pass filter which attains the property of required optical cut-off frequency according to the diffraction effect as an optical low pass filter may be adopted.

[0016]

An image sensor SR consists of CCD which has two or more pixels, and

changes into an electrical signal the optical image which the zoom lens system formed by CCD. Predetermined digital image processing, picture compression processing, etc. are performed to the signal generated with the image sensor SR if needed, it is recorded on memory (semiconductor memory, optical disk, etc.) as a digital video signal, a cable is minded depending on the case, or it is changed into an infrared signal, and is transmitted to other devices. In addition, a CMOS sensor (Complementary Metal-oxide Semiconductor) may be used instead of CCD.

[0017]

Drawing 1 thru/or drawing 9 are the block diagrams showing lens arrangement in the shortest focal distance condition of the zoom lens system contained in the image pick-up equipment of the 1st thru/or the 9th operation gestalt of this invention. In addition, in each drawing, the prism PR which has an internal reflection side is expressed with an parallel plate, and the optical path is expressed linearly.

[0018]

Monotonous PR in which the zoom lens system of the 1st operation gestalt is equivalent to the 1st lens element L1 which is from the negative meniscus lens

to which the convex was turned on a body side, and prism in order from a body side to an image side, since -- with the 1st lens group Gr1 constituted, and the 2nd lens element L2 of both the concave configuration and the 3rd lens element L3 of a forward meniscus configuration which turned the convex to the body side since -- with the 3rd lens group Gr3 which consists of 1st cemented lens components DL 1 which come to join the 2nd lens group Gr2 constituted, and Diaphragm ST, the 4th lens element L4 of both the convex configuration and the 5th lens element L5 of both the concave configuration the 5th lens group Gr5 which consists of a 4th lens group Gr4 which consists of 6th lens element L6 of a forward meniscus configuration which turned the concave surface to the body side, and the 7th lens element L7 of a negative meniscus configuration which turned the concave surface to the body side -- since -- it is constituted. Furthermore, parallel monotonous LPF equivalent to an optical low pass filter is arranged at the image side of the 5th lens group Gr5 of this zoom lens system.

[0019]

Zooming from the shortest focal distance condition to the longest focal distance condition is faced this zoom lens system. Are fixed to the image surface, and draw the locus of the letter of U-turn of a convex, and the 2nd lens group Gr2

moves it to an image side, as the 1st lens group Gr1 moves to a body side once moving to an image side. The 3rd lens group Gr3 moves to a body side almost in monotone united with the diaphragm ST arranged at the body side of the 3rd lens group Gr3. The 4th lens group Gr4 moves to an image side almost in monotone, and the 5th lens group Gr5 is being fixed to the image surface with parallel monotonous LPF arranged at the image side of the 5th lens group Gr5.

[0020]

Both sides of the 2nd lens element L2, the image side face of 6th lens element L6, and the body side face of the 7th lens element L7 have the aspheric surface configuration among the fields of a lens element, respectively.

[0021]

Monotonous PR by which the zoom lens system of the 2nd operation gestalt is equivalent to the 1st lens element L1 which is from the negative meniscus lens to which the convex was turned on a body side, and prism in order from a body side to an image side, The 1st lens group Gr1 which consists of the 2nd lens element L2 of a forward meniscus configuration which turned the convex to the body side, The 3rd lens element L3 of a negative meniscus configuration which turned the convex to the body side, and the 4th lens element L4 of a forward

meniscus configuration which turned the convex to the body side, since -- with the 3rd lens group Gr3 which consists of 1st cemented lens components DL 1 which come to join the 2nd lens group Gr2 constituted, and Diaphragm ST, the 5th lens element L5 of both the convex configuration and 6th lens element L6 of both the concave configuration the 5th lens group Gr5 which consists of a 4th lens group Gr4 which consists of the 7th lens element L7 of a forward meniscus configuration which turned the concave surface to the body side, and the 8th lens element L8 of a negative meniscus configuration which turned the convex to the body side -- since -- it is constituted. Furthermore, parallel monotonous LPF equivalent to an optical low pass filter is arranged at the image side of the 5th lens group Gr5 of this zoom lens system.

[0022]

Zooming from the shortest focal distance condition to the longest focal distance condition is faced this zoom lens system. Are fixed to the image surface, and draw the locus of the letter of U-turn of a convex, and the 2nd lens group Gr2 moves it to an image side, as the 1st lens group Gr1 moves to a body side once moving to an image side. The 3rd lens group Gr3 moves to a body side almost in monotone united with the diaphragm ST arranged at the body side of the 3rd

lens group Gr3. The 4th lens group Gr4 moves to an image side almost in monotone, and the 5th lens group Gr5 is being fixed to the image surface with parallel monotonous LPF arranged at the image side of the 5th lens group Gr5.

[0023]

The body side face of the 1st lens element L1, both sides of the 3rd lens element L3, the image side face of the 7th lens element L7, and the body side face of the 8th lens element L8 have the aspheric surface configuration among the fields of a lens element, respectively.

[0024]

Monotonous PR in which the zoom lens system of the 3rd operation gestalt is equivalent to the 1st lens element L1 which is from the negative meniscus lens to which the convex was turned on a body side, and prism in order from a body side to an image side, since -- with the 1st lens group Gr1 constituted, the 2nd lens element L2 of a negative meniscus configuration which turned the convex to the body side, and the 3rd lens element L3 of a forward meniscus configuration which turned the convex to the body side since -- with the 3rd lens group Gr3 which consists of 1st cemented lens components DL 1 which come to join the 2nd lens group Gr2 constituted, and Diaphragm ST, the 4th lens element L4 of

both the convex configuration and the 5th lens element L5 of both the concave configuration the 5th lens group Gr5 which consists of a 4th lens group Gr4 which consists of 6th lens element L6 of a forward meniscus configuration which turned the concave surface to the body side, and the 7th lens element L7 of a negative meniscus configuration which turned the convex to the body side -- since -- it is constituted. Furthermore, parallel monotonous LPF equivalent to an optical low pass filter is arranged at the image side of the 5th lens group Gr5 of this zoom lens system.

[0025]

Zooming from the shortest focal distance condition to the longest focal distance condition is faced this zoom lens system. Are fixed to the image surface, and draw the locus of the letter of U-turn of a convex, and the 2nd lens group Gr2 moves it to an image side, as the 1st lens group Gr1 moves to a body side once moving to an image side. The 3rd lens group Gr3 moves to a body side almost in monotone united with the diaphragm ST arranged at the body side of the 3rd lens group Gr3. The 4th lens group Gr4 moves to an image side almost in monotone, and the 5th lens group Gr5 is being fixed to the image surface with parallel monotonous LPF arranged at the image side of the 5th lens group Gr5.

[0026]

Both sides of the 2nd lens element L2, the image side face of the 5th lens element L5, and both sides of 6th lens element L6 have the aspheric surface configuration among the fields of a lens element, respectively.

[0027]

Monotonous PR in which the zoom lens system of the 4th operation gestalt is equivalent to the 1st lens element L1 which is from the negative meniscus lens to which the convex was turned on a body side, and prism in order from a body side to an image side, since -- with the 1st lens group Gr1 constituted, the 2nd lens element L2 of a negative meniscus configuration which turned the convex to the body side, and the 3rd lens element L3 of a forward meniscus configuration which turned the convex to the body side since -- with the 2nd lens group Gr2 constituted, and Diaphragm ST and the 4th lens element L4 of both the convex configuration The 3rd lens group Gr3 which consists of 1st cemented lens components DL 1 which come to join 6th lens element L6 of a negative meniscus configuration which turned the concave surface to the body side to the 5th lens element L5 of a forward meniscus configuration which turned the concave surface to the body side, the 4th lens group Gr4 which consists of the

7th lens element L7 of both the convex configuration -- since -- it is constituted. Furthermore, parallel monotonous LPF equivalent to an optical low pass filter is arranged at the image side of the 4th lens group Gr4 of this zoom lens system.

[0028]

Zooming from the shortest focal distance condition to the longest focal distance condition is faced this zoom lens system. Are fixed to the image surface, and draw the locus of the letter of U-turn of a convex, and the 1st lens group Gr1 moves it to an image side, as it once moves to an image side and the 2nd lens group Gr2 moves to a body side later. The 3rd lens group Gr3 United with the diaphragm ST arranged at the body side of the 3rd lens group Gr3, it moves to a body side almost in monotone, and the 4th lens group Gr4 moves to an image side almost in monotone, and parallel monotonous LPF is being fixed to the image surface.

[0029]

Both sides of the 2nd lens element L2, the image side face of 6th lens element L6, and both sides of the 7th lens element L7 have the aspheric surface configuration among the fields of a lens element, respectively.

[0030]

Monotonous PR in which the zoom lens system of the 5th operation gestalt is equivalent to the 1st lens element L1 which is from the negative meniscus lens to which the concave surface was turned on a body side, and prism in order from a body side to an image side, since -- with the 1st lens group Gr1 constituted, the 2nd lens element L2 of a negative meniscus configuration which turned the convex to the body side, and the 3rd lens element L3 of a forward meniscus configuration which turned the convex to the body side since -- with the 3rd lens group Gr3 which consists of 1st cemented lens components DL 1 which come to join the 2nd lens group Gr2 constituted, and Diaphragm ST, the 4th lens element L4 of both the convex configuration and the 5th lens element L5 of both the concave configuration the 4th lens group Gr4 which consists of 6th lens element L6 of a forward meniscus configuration which turned the convex to the body side -- since -- it is constituted. Furthermore, parallel monotonous LPF equivalent to an optical low pass filter is arranged at the image side of the 4th lens group Gr4 of this zoom lens system.

[0031]

Zooming from the shortest focal distance condition to the longest focal distance condition is faced this zoom lens system. Are fixed to the image surface, and

draw the locus of the letter of U-turn of a convex, and the 2nd lens group Gr2 moves it to an image side, as the 1st lens group Gr1 moves to a body side once moving to an image side. The 3rd lens group Gr3 moves to a body side almost in monotone united with the diaphragm ST arranged at the body side of the 3rd lens group Gr3, the 4th lens group Gr4 moves to an image side almost in monotone, and parallel monotonous LPF is being fixed to the image surface.

[0032]

Both sides of the 2nd lens element L2, the image side face of the 5th lens element L5, and both sides of 6th lens element L6 have the aspheric surface configuration among the fields of a lens element, respectively.

[0033]

Monotonous PR by which the zoom lens system of the 6th operation gestalt is equivalent to the 1st lens element L1 which is from the negative meniscus lens to which the convex was turned on a body side, and prism in order from a body side to an image side, the 2nd lens element L2 of a negative meniscus configuration which turned the convex to the body side, and the 3rd lens element L3 of a forward meniscus configuration which turned the convex to the body side -- since -- with the 1st lens group Gr1 constituted The 2nd lens group Gr2 which

consists of 1st cemented lens components DL 1 which come to join drawing ST, and the 4th lens element L4 of both the convex configuration and the 5th lens element L5 of both the concave configuration, the 4th lens group Gr4 which consists of 6th lens element L6 of a negative meniscus configuration which turned the concave surface to the body side, and the 7th lens group Gr5 which consists of the 7th lens element L7 of a negative meniscus configuration which turned the concave surface to the body side -- since -- it is constituted. Furthermore, parallel monotonous LPF equivalent to an optical low pass filter is arranged at the image side of the 4th lens group Gr4 of this zoom lens system.

[0034]

Zooming from the shortest focal distance condition to the longest focal distance condition is faced this zoom lens system. As the 1st lens group Gr1 moves to a body side once moving to an image side, the locus of the letter of U-turn of a convex is drawn, and it moves to an image side. The 2nd lens group Gr2 United with the diaphragm ST arranged at the body side of the 2nd lens group Gr2, it moves to a body side almost in monotone, and the 3rd lens group Gr3 moves to an image side almost in monotone, and the 4th lens group Gr4 is being fixed to the image surface with parallel monotonous LPF.

[0035]

It has the aspheric surface configuration among the fields of a lens element, respectively with both sides of the 2nd lens element L2, the image side face of the 5th lens L5, and the body side face of 6th lens element L6.

[0036]

The 1st lens group Gr1 by which the zoom lens system of the 7th operation gestalt is constituted from monotonous PR by which it is equivalent to the 1st lens element L1 of both the concave configuration, and prism in order from a body side to an image side, The 2nd lens element L2 of a forward meniscus configuration which turned the convex to the body side, and the 3rd lens element L3 of a negative meniscus configuration which turned the convex to the body side, It extracts. since -- it has been arranged between the 2nd lens group Gr2 constituted, and this 2nd lens element L2 and the 3rd lens element L3 -- with ST the 3rd lens group Gr3 which consists of the 4th lens element L4 of both the convex configuration, the 5th lens element L5 of a negative meniscus configuration which turned the convex to the body side, and the 4th lens group Gr4 which consists of 6th lens element L6 of both the convex configuration -- since -- it is constituted. Furthermore, parallel monotonous LPF equivalent to an

optical low pass filter is arranged at the image side of the 4th lens group Gr4 of this zoom lens system.

[0037]

On the occasion of zooming from the shortest focal distance condition to the longest focal distance condition, the 1st lens group Gr1 is fixed to the image surface, this zoom lens system is moved to a body side almost in monotone [the 2nd lens group Gr2], the 3rd lens group Gr3 moves to a body side almost in monotone united with Diaphragm ST, and the 4th lens group Gr4 is being fixed to the image surface with parallel monotonous LPF.

[0038]

It has the aspheric surface configuration among the fields of a lens element, respectively with both sides of the 1st lens element L1, the body side face of the 2nd lens element L2 and both sides of the 3rd lens L3, and the image side face of 6th lens element L6.

[0039]

The 1st lens group Gr1 by which the zoom lens system of the 8th operation gestalt is constituted from monotonous PR by which it is equivalent to the 1st lens element L1 of both the concave configuration, and prism in order from a

body side to an image side, The 2nd lens element L2 of a forward meniscus configuration which turned the convex to the body side, and the 3rd lens element L3 of a negative meniscus configuration which turned the convex to the body side, It extracts. since -- it has been arranged between the 2nd lens group Gr2 constituted, and this 2nd lens element L2 and the 3rd lens element L3 -- with ST the 3rd lens group Gr3 which consists of the 4th lens element L4 of both the convex configuration, the 5th lens element L5 of a negative meniscus configuration which turned the concave surface to the body side, and the 4th lens group Gr4 which consists of 6th lens element L6 of both the convex configuration -- since -- it is constituted. Furthermore, parallel monotonous LPF equivalent to an optical low pass filter is arranged at the image side of the 4th lens group Gr4 of this zoom lens system.

[0040]

On the occasion of zooming from the shortest focal distance condition to the longest focal distance condition, the 1st lens group Gr1 is fixed for this zoom lens system to the image surface. The 2nd lens group Gr2 It extracts drawing the locus of a convex on a body side, and moves to a body side united with ST, and the 3rd lens group Gr3 moves to a body side almost in monotone, the 4th lens

group Gr4 moves to an image side almost in monotone, and parallel monotonous LPF is being fixed to the image surface.

[0041]

Zooming from the shortest focal distance condition to the longest focal distance condition is faced this zoom lens system. As the 1st lens group Gr1 moves to a body side once moving to an image side, the locus of the letter of U-turn of a convex is drawn, and it moves to an image side. The 2nd lens group Gr2 United with the diaphragm ST arranged at the body side of the 2nd lens group Gr2, it moves to a body side almost in monotone, and the 3rd lens group Gr3 moves to an image side almost in monotone, and the 4th lens group Gr4 is being fixed to the image surface with parallel monotonous LPF.

[0042]

It has the aspheric surface configuration among the fields of a lens element, respectively with both sides of the 1st lens element L1, the body side face of the 2nd lens element L2 and both sides of the 3rd lens L3, and the image side face of 6th lens element L6.

[0043]

The 1st lens group Gr1 by which the zoom lens system of the 9th operation

gestalt is constituted from monotonous PR by which it is equivalent to the 1st lens element L1 of both the concave configuration, and prism in order from a body side to an image side, The 2nd lens group Gr2 which consists of the 2nd lens element L2 of a forward meniscus configuration which turned the convex to the body side, Drawing ST and the 3rd lens group Gr3 which consists of the 3rd lens element L3 of a negative meniscus configuration which turned the convex to the body side, the 5th lens group Gr5 which consists of a 4th lens group Gr4 which consists of the 4th lens element L4 of both the convex configuration, the 5th lens element L5 of a negative meniscus configuration which turned the convex to the body side, and 6th lens element L6 of a forward meniscus configuration which turned the convex to the body side -- since -- it is constituted. Furthermore, parallel monotonous LPF equivalent to an optical low pass filter is arranged at the image side of the 5th lens group Gr5 of this zoom lens system.

[0044]

On the occasion of zooming from the shortest focal distance condition to the longest focal distance condition, the 1st lens group Gr1 is fixed for this zoom lens system to the image surface. The 2nd lens group Gr2 It extracts drawing the locus of a convex on a body side, and moves to a body side united with ST, and

the 3rd lens group Gr3 moves to a body side almost in monotone, the 4th lens group Gr4 moves to a body side almost in monotone, and the 5th lens group Gr5 is being fixed to the image surface with parallel monotonous LPF.

[0045]

It has the aspheric surface configuration among the fields of a lens element, respectively with both sides of the 1st lens element L1, the body side face of the 2nd lens element L2 and both sides of the 3rd lens L3, and the image side face of 6th lens element L6.

[0046]

The zoom lens system of each operation gestalt is equipped with Rhythm PR so that it may have the reflector which bends the optical axis of body light 90 degrees of abbreviation in the interior of the 1st group. Thus, it becomes possible by bending the optical axis of body light 90 degrees of abbreviation to attain thin shape-ization on the appearance of image pick-up equipment.

[0047]

When a digital camera is considered for an example, image pick-up equipment including a zoom lens system occupies the biggest volume in equipment. the zoom lens system by which the magnitude of the thickness direction of a camera

is especially contained in image pick-up equipment like a film camera conventional with a digital camera lens shutter type when optical elements contained in a zoom lens system, such as a lens and a diaphragm, are arranged linearly, without changing the direction of an optical axis -- it is most determined as a matter of fact in the magnitude from the configuration by the side of a body to an image sensor. However, the aberration amendment level of image pick-up equipment is also improving by leaps and bounds with a raise in a pixel to an image sensor in recent years. For this reason, the thing to which the number of sheets of the lens element of the zoom lens system contained in image pick-up equipment is also increasing steadily and for which a thin shape is attained also in the time (the so-called collapsed state) of un-using it for the thickness of a lens element is difficult.

[0048]

On the other hand, since it becomes possible to make [by adopting the configuration which bends the optical axis of body light 90 degrees of abbreviation according to a reflector like the zoom lens system of each operation gestalt] small most magnitude of the thickness direction of image pick-up equipment to the magnitude from the lens by the side of a body to a reflector at

the time of un-using it, it becomes possible to attain thin shape-ization on the appearance of image pick-up equipment. Moreover, since the optical path of body light can be piled up near the reflector by adopting the configuration which bends the optical axis of body light 90 degrees of abbreviation according to a reflector, space can be used effectively and the further miniaturization of image pick-up equipment can be attained.

[0049]

As for the location of a reflector, it is desirable that it is the 1st lens group Gr1 interior. By arranging to the 1st lens group Gr1 interior arranged most at the body side, it becomes possible to make magnitude of the thickness direction of image pick-up equipment into min.

[0050]

As for the 1st lens group Gr1 in which a reflector is included, it is desirable to have negative power. When the 1st lens group Gr1 has negative power, it becomes possible to make magnitude of the reflector in a reflector location small. Moreover, a zoom lens system becomes the so-called negative lead type by adopting the configuration whose 1st lens group Gr1 has negative power. As for a negative lead type zoom lens system, in a large focal distance field, it becomes

easy and is desirable to attain image side tele cent rucksack nature required for the optical system for being easy to take a retro focus type configuration, and forming an optical image in an image sensor.

[0051]

Although (a) internal reflection prism (operation gestalt), (b) surface reflecting prism, (C) internal reflection monotonous mirror, a (d) surface reflective mirror, and ******** may be used for a reflector, its (a) internal reflection prism is the optimal. In order that body light may pass through the inside of the medium of prism by adopting internal reflection prism, the spacing at the time of penetrating prism turns into a short conversion spacing from spacing more nearly physical than the usual air spacing according to the refractive index of a medium. For this reason, when internal reflection prism is adopted as a configuration of a reflector, an equivalent configuration can be attained in a compacter tooth space, and it is optically desirable.

[0052]

When it constitutes a reflector from internal reflection prism, as for the quality of the material of prism, it is desirable to satisfy the following conditions.

[0053]

Np>=1.55 .... (1)

It corrects,

Np is the refractive index of the quality of the material of prism,

It comes out.

[0054]

If the refractive index of prism turns around the above-mentioned range the bottom, the contribution to miniaturization becomes small and is not desirable.

[0055]

Furthermore, it is desirable that it is in the following range in addition to the above-mentioned range.

[0056]

Np>=1.7 .... (1)'

Moreover, a reflector may not be a perfect total reflection side. Some reflection factors are suitably adjusted among reflectors, it is made to branch and incidence of a part of body light may be carried out to the sensor for a photometry or ranging. Furthermore, the reflection factor of the whole reflector surface may be adjusted suitably, and finder light may be branched. Furthermore, with each operation gestalt, although each of plane of incidence of

prism and outgoing radiation sides is flat surfaces, you may be a field with power.

[0057]

As for a body side, it is more desirable than a reflector to consist of lens elements of one sheet. Since the substantial thickness of optical system will be determined by the structure of having Rhythm PR, at spacing from the body side face of the lens arranged most at the body side to a reflector so that it may have the reflector which bends the optical axis of body light 90 degrees of abbreviation in the interior of the 1st group, it becomes possible from a reflector to acquire thin optical system by constituting the configuration by the side of a body from a lens element of one sheet. Moreover, the degree of freedom of a camera cone configuration can be made to increase, and low cost-ization of image pick-up equipment can be attained.

[0058]

Furthermore, as for the 1st lens group Gr1, it is desirable at the time of variable power that it is immobilization to the image surface. While needing a big tooth space when it is made to move since the reflector is included in the 1st lens group Gr1, when the reflector is especially constituted from prism, prism with big weight must be moved, a drive will be forced a big burden, and it is not desirable.

Moreover, by making the 1st lens group Gr1 immobilization to the image surface at the time of variable power, the optical system which does not carry out overall-length change can be acquired, and it is desirable. Moreover, a camera cone configuration can also be simplified and it becomes possible to attain low cost-ization of the whole image pick-up equipment. Furthermore, since initialization of the control system for control of a migration group becomes easy especially in a digital camera at the time of a zoom by adopting the configuration which fixes the 1st lens group Gr1 at the time of zooming, it becomes [to shorten time amount required by the condition which can be photoed] possible from the time of a main power supply ON and is desirable.

[0059]

The configuration which also makes negative power the 2nd lens group Gr2 following the 1st lens group Gr1 which has negative power is used for the zoom lens system of each operation gestalt. It is easy to adopt the configuration which makes the above-mentioned 1st lens group immobilization by this configuration and is desirable.

[0060]

As for the zoom lens system of each operation gestalt, it is desirable to satisfy

the following conditions.

[0061]

Next, conditions with desirable the gestalt of each operation being satisfied are explained. In addition, although it is possible to attain the operation effectiveness corresponding to it if each conditions that the following explains are satisfied independently, respectively, it cannot be overemphasized that it is more more desirable from optical-character ability and a viewpoint of a miniaturization to satisfy two or more conditions.

[0062]

As for the zoom lens system of each operation gestalt, it is desirable to satisfy the following conditions.

[0063]

$0.5 < |F1 / F2| < 5$ .... (2)

It corrects,

f1: The focal distance of the 1st lens group Gr1,

f2: The focal distance of the 2nd lens group Gr2,

It comes out.

[0064]

As for conditions (2), the 1st lens group Gr1 had negative power, and the 2nd lens group Gr2 has specified the desirable focal distance ratio of the 1st lens group Gr1 and the 2nd lens group Gr2 in the configuration (for example, an example 1 thru/or 5) which has negative power. If the minimum of conditions (2) is exceeded, since the focal distance of the 1st lens group Gr1 will become short too much, distortion aberration (especially negative distortion aberration in the shortest focal distance condition) becomes remarkable, and it becomes difficult to secure good optical-character ability. On the contrary, if the upper limit of conditions (2) is exceeded, since the focal distance of the 1st lens group Gr1 will become long too much, the negative power of the 1st lens group Gr1 becomes weak, will cause increase of the diameter of a lens of the 1st lens group Gr1, and is not desirable in respect of miniaturization.

[0065]

Furthermore, as for the zoom lens system of each operation gestalt, it is desirable to satisfy the following conditions.

[0066]

$1.5 < |F12W| / Fw < 4$ .... (3)

It corrects,

f12w: The synthetic focal distance of the 1st lens group Gr1 in the shortest focal distance condition, and the 2nd lens group Gr2,

fw: The focal distance in the shortest focal distance condition of the whole system,

It comes out.

[0067]

Conditions (3) have power negative in the 1st lens group Gr1, and the 2nd lens groups Gr2 are the conditions about the synthetic focal distance of the 1st lens group Gr1 in the shortest focal distance condition, and the 2nd lens group Gr2 in the configuration (for example, an example 1 thru/or 5) which has negative power. While an overall length will increase since the synthetic focal distance of the 1st lens group Gr1 and the 2nd lens group Gr2 becomes long too much if the upper limit of conditions (3) is exceeded, since the synthetic power of the 1st lens group Gr1 and the 2nd lens group Gr2 becomes weak, the diameter of a lens becomes large. Therefore, it becomes difficult to obtain a compact zoom lens system. On the contrary, if the minimum of conditions (3) is exceeded, since the synthetic focal distance of the 1st lens group Gr1 and the 2nd lens group Gr2 will become short too much, the negative distortion aberration generated in the

state of the shortest focal distance by the 1st lens group Gr1 and the 2nd lens group Gr2 becomes large too much, and amendment becomes difficult.

[0068]

Furthermore, as for the zoom lens system of each operation gestalt, it is desirable to satisfy the following conditions.

[0069]

$0.4 < |F12W| / F3 < 1.5$ .... (4)

It corrects,

f12w: The synthetic focal distance of the 1st lens group Gr1 in the shortest focal distance condition, and the 2nd lens group Gr2,

f3: The focal distance of the 3rd lens group Gr3,

It comes out.

[0070]

Conditions (4) have power negative in the 1st lens group Gr1, and the 2nd lens groups Gr2 are the conditions about the ratio of the synthetic focal distance of the 1st lens group Gr1 in the shortest focal distance condition, and the 2nd lens group Gr2, and the focal distance of the 3rd lens group in the configuration (for example, an example 1 thru/or 5) which has negative power. If the upper limit of

conditions (4) is exceeded, it means that the synthetic focal distance of the 1st lens group Gr1 and the 2nd lens group Gr2 becomes long relatively. For this reason, if the upper limit of conditions (4) is exceeded, an exit pupil location will move to an image side, and is not desirable. On the contrary, if the minimum of conditions (3) is exceeded, since the synthetic focal distance of the 1st lens group Gr1 and the 2nd lens group Gr2 will become short too much, the negative distortion aberration generated in the state of the shortest focal distance by the 1st lens group Gr1 and the 2nd lens group Gr2 becomes large too much, and amendment becomes difficult.

[0071]

$2 < |f1 / fw| < 4$ (5)

It corrects,

f1: The focal distance of the 1st lens group,

fw: The focal distance in the wide angle edge of the whole system,

It comes out.

[0072]

Conditional expression (5) had power negative in the 1st lens group Gr1, and the 2nd lens group Gr2 has specified the desirable focal distance of the 1st lens

group Gr1 in the configuration (for example, an example 6 thru/or 9) which has forward power. If the upper limit of conditional expression (5) is exceeded, since the focal distance of the 1st lens group Gr1 will become large too much, an overall length or distance from a reflector to an image sensor cannot be made small as a result, and it is not desirable. Since the negative power of the 1st lens group Gr1 becomes weak too much, the lens outer diameter which constitutes the 1st lens group Gr1 becomes large, and it becomes impossible moreover, to attain a compact zoom lens system. Conversely, if the minimum of conditional expression (5) is exceeded, since the focal distance of the 1st lens group Gr1 will become short too much, the negative distortion generated by the 1st lens group Gr1 in a wide angle edge becomes large too much, and it becomes difficult to perform the amendment.

[0073]

Although each lens group which constitutes each operation gestalt consists of only refraction mold lenses (that is, lens of the type with which a deviation is performed by the interface of the media which have a different refractive index) which deflect an incident ray by refraction, it is not restricted to this. For example, each lens group may consist of a diffraction mold lens which deflects an incident

ray by diffraction, a refraction / diffraction hybrid mold lens which deflects an incident ray with the combination of a diffraction operation and a refraction operation, a refractive-index distribution lens which deflects an incident ray according to the refractive-index distribution in a medium.

[0074]

[Example]

Construction data, an aberration Fig., etc. are mentioned and the configuration of the zoom lens system hereafter contained in the image pick-up equipment which carried out this invention etc. is explained still more concretely. The lens block diagram (drawing 1 thru/or 9) which the example 1 explained as an example here thru/or 4 support the 1st thru/or 9th operation gestalt mentioned above, respectively, and expresses the 1st thru/or 9th operation gestalt shows a corresponding example 1 thru/or the corresponding lens configuration of 9, respectively.

[0075]

In the construction data of each example, ri (i = 1, 2, 3 ....) is counted from a body side. The radius of curvature of the i-th field (mm), Count di (i = 1, 2, 3 ....) from a body side, and the i-th axial top-face spacing (mm) is shown. nickel (i = 1,

2, 3 ....) and nui (i = 1, 2, 3 ....) are counted from a body side, and show the refractive index (Nd) and the Abbe number (nud) to d line of the i-th optical element. Moreover, axial top-face spacing which changes in zooming shows the value of the variable spacing in the shortest focal distance condition (wide angle edge, W) - middle focal distance condition (middle, M) - longest focal distance condition (a tele edge, T) among construction data. The focal distance (f, mm) and the f number (FNO) of the whole system corresponding to each focal distance condition (W), (M), and (T) are combined with other data, and are shown.

[0076]

It shall be shown that the field where * was given to radius of curvature ri is a field which consisted of the aspheric surfaces, and it shall define as the formula (AS) of the following showing the field configuration of the aspheric surface. The aspheric surface data of each example are combined with other data, and are shown.

[0077]

A10= 0.25333947D-07

r13*

ε = 0.10000000D+01

A4 = 0.11420046D-02

A6 = 0.61304067D-04

A8 = -0.24678605D-05

A10= 0.38078980D-06

r14*

ε = 0.10000000D+01

A4 = -0.17175253D-02

A6 = 0.35415900D-04

A8 = -0.51967472D-05

A10= 0.10804669D-06

《実施例２》

f = 5.1 - 8.9 - 14.7

Fno.= 2.16 - 2.97 - 4.10

[曲率半径]	[軸上面間隔]	[屈折率(Nd)]	[アッベ数(νd)]
r1* = 77.048			
	d1 = 1.000	N1 = 1.66602	ν1 = 30.12
r2 = 10.412			
	d2 = 3.701		
r3 = ∞			
	d3 = 12.400	N2 = 1.84666	ν2 = 23.82
r4 = ∞			
	d4 = 0.200		
r5 = 12.063			

d5 = 1.645 N3 = 1.84898 ν3 = 33.15

r6 = 22.797

d6 = 2.045 - 5.298 - 3.490

r7*= 74.513

d7 = 1.000 N4 = 1.52510 ν4 = 56.38

r8*= 6.297

d8 = 1.041

r9 = 7.766

d9 = 1.464 N5 = 1.79850 ν5 = 22.6

r10= 10.311

d10= 13.841 - 5.438 - 1.000

r11= ∞

d11= 0.600

r12= 6.616

d12= 5.892 N6 = 1.75450 ν6 = 51.57

r13= -10.215

d13= 1.000 N7 = 1.84666 ν7 = 23.82

r14*= 18.124

d14= 2.079 - 8.055 - 15.451

r15*=-23.464

d15= 3.400 N8 = 1.52510 ν8 = 56.82

r16 =-6.333

d16= 2.476 - 1.650 - 0.500

r17 = 14.316

d17= 1.000 N9 = 1.84833 ν9 = 29.89

r18= 10.360

d18= 0.907

r19= ∞

d19= 2.000 N10= 1.51680 ν10= 64.20

r20= ∞

[非球面係数]

r1*

ε = 0.10000000E+01

A4 = 0.63638407E-04

A6 = -0.36516691E-06

A8 = 0.15861666E-08

r7*

ε = 0.10000000E+01

A4= -0.63173747E-03

A6= 0.42880271E-04

A8 = -0.13655536E-05

A10= 0.17341485E-07

r8*

ε = 0.10000000E+01

A4 = -0.78352207E-03

A6 = 0.45124782E-04

A8 = -0.17639048E-05

A10= 0.22553499E-07

r15*

ε = 0.10000000E+01

A4 = 0.10864595E-02

A6 = 0.63616957E-04

A8 = -0.36734216E-05

A10= 0.41688467E-06

r16*

ε = 0.10000000E+01

A4 = -0.14356439E-02

A6 = 0.25426605E-04

A8 = -0.32121190E-05

A10= 0.95302924E-07

《実施例3》

f = 4.5 - 7.9 - 12.9

Fno.= 2.1 - 2.8 - 3.7

[曲率半径]	[軸上面間隔]	[屈折率(Nd)]	[アッベ数(νd)]
r1 = 4101.218			
	d1 = 0.700	N1 = 1.78589	ν1 = 44.20
r2 = 19.552			
	d2 = 0.900		
r3 = ∞			
	d3 = 8.000	N2 = 1.84666	ν2 = 23.82
r4 = ∞			
	d4 = 1.000 - 3.596 - 1.000		
r5*= 56.521			
	d5 = 0.800	N3 = 1.57501	ν3 = 41.49
r6*= 4.357			
	d6 = 1.021		
r7 = 7.895			
	d7 = 1.6000	N4 = 1.84666	ν4 = 23.82
r8 = 21.921			
	d8 = 10.752 - 3.530 - 0.969		
r9 = ∞			

d９ ＝ ０．６５０

r10=5.274

d10= 4.755 N5 = 1.75450 ν5 = 51.57

r11=-9.977

d11= 0.010 N6 = 1.51400 ν6 = 42.83

r12=-9.977

d12= 0.800 N7 = 1.84666 ν7 = 23.82

r13*=15.094

d13= 2.179 - 7.261 - 12.815

r14*=-25.000

d14= 3.200 N8 = 1.52510 ν8 = 56.38

r15*= -5.767

d15= 1.453 - 0.996 - 0.600

r16= 10.099

d16= 0.983 N9 = 1.70055 ν9 = 30.11

r17= 6.767

d17= 0.948

r18= ∞

d18= 1.500 N10= 1.51680 ν10= 64.20

r19= ∞

[非球面係数]

r5*

ε = 0.10000000E+01

A4 = -0.44053024E-03

A6 = -0.45582866E-04

A8 = 0.56807258E-05

A10= -0.21748168E-06

r6*

ε = 0.10000000E+01

A4 = -0.19077667E-02

A6 = -0.45431102E-04

A8 = -0.17609821E-05

A10= -0.26911785E-08

r13*

ε = 0.10000000E+01

A4 = 0.24256912E-02

A6 = 0.13113475E-03

A8 = -0.19935678E-05

A10= 0.20427432E-05

r14*

ε = 0.10000000E+01

A4 = -0.76241384E-03

A6 = -0.45684352E-04

A8 = 0.74367662E-05

A10= 0.17395830E-06

r15*

ε = 0.10000000E+01

A4 = 0.16617833E-02

A6 = -0.97370809E-04

A8 = 0.83998804E-05

《実施例４》

f = 4.5 - 7.6 - 12.9

Fno.= 2.1 - 2.8 - 2.97

[曲率半径]　[軸上面間隔]　[屈折率(Nd)]　[アッベ数(νd)]

r1 = -25.000

d1 = 0.800　N1 = 1.63980　ν1 = 34.55

r2 =-115.843

d2 = 0.100

r3 = ∞

d3 = 9.200　N2 = 1.84666　ν2 = 23.82

r4 = ∞

d4 = 1.000 - 4.551 - 2.772

r5*= 21.359

d5 = 0.800　N3 = 1.83400　ν3 = 37.15

r6*= 5.824

d6 = 3.352

r7 = 14.337

d7 = 1.500　N4 = 1.84666　ν4 = 23.82

r8 = 52.503

d8 = 12.765 - 4.785 - 0.910

r9 = ∞

d9 = 0.700

r10= 12.888

d10= 2.200　N5 = 1.75450　ν5 = 51.57

r11= -36.914

d11= 0.100

r12= 4.598

d12= 3.800　N6 = 1.48749　ν6 = 70.44

r13= 181.628

d13= 0.010　N7 = 1.51400　ν7 = 42.83

r13= 181.628

d14 = 1.000　　N8 = 1.84666　　ν8 = 23.82

r15*= 3.955

d15= 1.500 - 6.298 - 12.506

r16* = 10.062

d16= 2.000　　N9 = 1.48749　　ν9 = 70.44

r17*=-8.840

d17= 1.472 - 1.104 - 0.600

r18= ∞

d18= 1.700　　N10= 1.51680　　ν10= 64.20

r19= ∞

[非球面係数]

r5*

ε = 0.10000000E+01

A4 = 0.28920160E-03

A6 = -0.24770223E-04

A8 = 0.40226114E-06

r6*

ε = 0.10000000E+01

A4 = -0.28416506E-03

A6 = -0.39127534E-04

A8 = 0.10049102E-06

r15*

ε = 0.10000000E+01

A4 = 0.22971891E-02

A6 = 0.61362182E-04

A8 = 0.38054044E-04

r16*

ε = 0.10000000E+01

A4 = 0.29657551E-02

A6 = -0.32988137E-03

A8 = 0.18146796E-04

r17*

ε = 0.10000000E+01

A4 = 0.65616586E-02

A6 = -0.68518707E-03

A8 = 0.33543925E-04

《実施例５》

f = 4.5 - 7.9 - 12.9

Fno.= 2.1 - 2.89 - 3.8

[曲率半径]	[軸上面間隔]	[屈折率(Nd)]	[アッベ数(νd)]
r1 = 16.688			
	d1 = 0.800	N1 = 1.54072	ν1 = 47.22
r2 = 7.343			
	d2 = 2.500		
r3 = ∞			
	d3 = 8.400	N2 = 1.84666	ν2 = 23.82
r4 = ∞			
	d4 = 1.500 - 2.971 - 1.500		
r5*=164.473			
	d5 = 0.800	N3 = 1.62004	ν3 = 36.26
r6*= 4.995			
	d6 = 1.353		
r7 =10.132			

d7 = 2.267　　N4 = 1.84666　　ν4 = 23.82

r8 = 69.912

　　d8 = 11.101 - 4.724 - 0.862

r9 = ∞

　　d9 = 0.650

r10= 5.681

　　d10= 5.504　　N5 = 1.75450　　ν5 = 51.57

r11= -10.007

　　d11= 0.010　　N6 = 1.51400　　ν6 = 42.83

r12 =-10.007

　　d12= 0.800　　N7 = 1.84666　　ν7 = 23.82

r13*= 13.518

　　d13= 1.987 - 8.774 - 14.499

r14*= 72.616

　　d14= 3.700　　N8 = 1.52510　　ν8 = 56.38

r15*=-8.793

　　d15= 3.078 - 1.197 - 0.806

r16= ∞

　　d16= 1.500　　N9 = 1.51680　　ν9 = 64.20

[非球面係数]

r5*

ε = 0.10000000E+01

A4 = -0.50212557E-03

A6 = 0.58262738E-04

A8 = -0.45960476E-05

A10= 0.10745067E-06

r6*

ε = 0.10000000E+01
A4 = -0.17341477E-02
A6 = 0.76117570E-04
A8 = -0.99234139E-05
A10= 0.25780579E-06

r13*
ε = 0.10000000E+01
A4 = 0.22365769E-02
A6 = 0.79579971E-04
A8 = 0.53500363E-05
A10= 0.10651891E-05

r14*
ε = 0.10000000E+01
A4 = -0.74920577E-03
A6 = -0.44003627E-04
A8 = -0.46232075E-05
A10= 0.52351697E-06

r15*
ε = 0.10000000E+01
A4 = 0.27419718E-03
A6 = -0.15545535E-03
A8 = 0.68734468E-05

《実施例６》
f = 5.1 - 8.9 - 14.7
Fno. = 2.24 - 2.98 - 4.10

[曲率半径]	[軸上面間隔]	[屈折率(Nd)]	[アッベ数(νd)]
r1* = 17.487			
	d1 = 1.000	N1 = 1.733922	ν1 = 29.35
r2 = 10.704			
	d2 = 3.877		
r3 = ∞			
	d3 =12.400	N2 = 1.84666	ν2 = 23.82
r4 = ∞			
	d4 = 1.500		
r5*= 213.855			
	d5 = 1.000	N3 = 1.61203	ν3 = 52.33
r6*= 5.360			
	d6 = 1.317		
r7 = 9.257			
	d7 = 1.649	N4 = 1.84666	ν4 = 23.82
r8 = 23.872			
	d8 = 12.037 - 4.771 - 1.000		
r9 = ∞			
	d9 = 0.600		
r10= 6.464			
	d10= 6.219	N5 = 1.75450	ν5 = 51.57
r11=-7.306			
	d11= 1.000	N6 = 1.84666	ν6 = 23.82
r12*= 33.980			
	d12= 2.038 - 7.101 - 13.534		
r13*= -17.735			
	d13= 3.475	N7 = 1.52510	ν7 = 56.38
r14= -5.800			
	d14= 2.546 - 1.749 - 0.500		

r15= -10.504

d15= 1.000　　N8 = 1.48749　　ν8 = 70.44

r16= -32.714

d16= 0.109

r17= ∞

d17= 2.000　　N9 = 1.51680　　ν9 = 64.20

r18= ∞

[非球面係数]

r5*

ε = 0.10000000E+01

A4 = -0.17088362E-03

A6 = -0.59468528E-06

A8 = 0.17670065E-06

A10= -0.21232398E-09

r6*

ε = 0.10000000E+01

A4 = -0.78520204E-03

A6 = -0.18852025E-04

A8 = -0.22264586E-06

A10= 0.62844746E-08

r13*

ε = 0.10000000E+01

A4 = 0.12126439E-02

A6 = 0.68930495E-04

A8 = -0.29394404E-05

A10= 0.46789735E-06

r14*

ε = 0.10000000E+01

A4 = -0.16889906E-02

A6 = 0.41032113E-04

A8 = -0.67973071E-05

A10= 0.22276351E-06

《実施例７》

f = 5.8 - 11.6 - 16.7

Fno.= 3.60 - 3.60 - 3.66

[曲率半径]	[軸上面間隔]	[屈折率(Nd)]	[アッベ数(νd)]
r1* =-11.725			
	d1 = 1.200	N1 = 1.49310	ν1 = 83.58
r2* = 13.872			
	d2 = 1.410		
r3 = ∞			
	d3 = 7.000	N2 = 1.84666	ν2 = 23.82
r4 = ∞			
	d4 = 22.033 - 8.278 - 0.600		
r5 = 6.671			
	d5 = 2.562	N3 = 1.75450	ν3 = 51.57
r6 = 35.072			

d6 = 0.600

r7 = ∞

d7 = 0.600

r8* = 18.236

d8 = 0.800 N4 = 1.84666 ν4 = 23.82

r9* = 8.198

d9 = 7.034 - 16.244 - 14.414

r10 = 39.487

d10 = 2.334 N5 = 1.49310 ν5 = 83.58

r11 = -13.184

d11 = 3.125 - 7.669 - 17.177

r12 = 21.757

d12 = 0.800 N6 = 1.84666 ν6 = 23.82

r13 = 9.428

d13 = 0.175

r14 = 10.828

d14 = 2.272 N7 = 1.50467 ν7 = 59.44

r15* = -70.639

d15 = 1.665

r16 = ∞

d16 = 2.000 N8 = 1.51680 ν8 = 64.20

r17 = ∞

[非球面係数]

r1*

ε = 0.10000E+01

A4 = 0.39770E-03

A6 = 0.48251E-05

A8 = -0.13574E-06

A10= 0.82447E-09

r2*

ε = 0.10000E+01

A4 = 0.12088E-03

A6 = 0.37656E-05

A8 = 0.23199E-06

A10= -0.73492E-08

r8*

ε = 0.10000E+01

A4 = 0.53711E-03

A6 = 0.22090E-04

A8 = -0.48503E-05

A10= 0.21033E-06

r9*

ε = 0.10000E+01

A4 = 0.14617E-02

A6 = 0.84785E-04

A8 = -0.97230E-05

A10= 0.62378E-06

r15*

ε = 0.10000E+01

A4 = 0.11315E-02

A6 = -0.58783E-04

A8 = 0.63291E-05

A10= -0.18581E-06

《実施例８》

f = 6.0 - 12.0 - 17.3

Fno. = 3.60 - 3.60 - 3.60

[曲率半径]	[軸上面間隔]	[屈折率(Nd)]	[アッベ数(νd)]
r1* =-72.486			
	d1 = 1.200	N1 = 1.49310	ν1 = 83.58
r2* = 8.054			
	d2 = 2.476		
r3 = ∞			
	d3 = 9.000	N2 = 1.84666	ν2 = 23.82
r4 = ∞			
	d4 = 21.244 - 4.060 - 0.600		
r5 = 6.766			
	d5 = 2.652	N3 = 1.79719	ν3 = 45.34
r6 = 17.430			
	d6 = 1.000		
r7 = ∞			
	d7 = 0.686		
r8* = 93.830			
	d8 = 0.800	N4 = 1.84666	ν4 = 23.82
r9* = 12.440			
	d9 = 3.714 - 12.381 - 9.898		
r10 = 22.538			
	d10 = 2.473	N5 = 1.49310	ν5 = 83.58
r11 = -15.873			
	d11 = 1.500 - 9.644 - 21.642		
r12 = -11.841			
	d12 = 0.800	N6 = 1.84666	ν6 = 23.82

r13 = -27.408

d13 = 0.100

r14 = 16.037

d14 = 2.349 N7 = 1.72904 ν7 = 52.47

r15* = -57.477

d15 = 6.683 - 7.055 - 1.000

r16 = ∞

d16 = 2.000 N8 = 1.51680 ν8 = 64.20

r17 = ∞

[非球面係数]

r1*

ε = 0.10000E+01

A4 = -0.24017E-05

A6 = 0.29455E-05

A8 = -0.30412E-07

A10= 0.12502E-10

r2*

ε = 0.10000E+01

A4 = -0.18797E-03

A6 = -0.38877E-05

A8 = 0.34374E-06

A10= -0.63589E-08

r8*

ε = 0.10000E+01

A4 = 0.58124E-03

A6 = 0.33012E-04

A8 = -0.45331E-05

A10= 0.17297E-06

r9*

ε = 0.10000E+01

A4 = 0.13667E-02

A6 = 0.79666E-04

A8 = -0.97230E-05

A10= -0.77035E-05

r15*

ε = 0.10000E+01

A4 = 0.63869E-04

A6 = -0.71764E-04

A8 = 0.36999E-05

A10= -0.66315E-06

《実施例９》

f = 5.8 - 11.6 - 16.7

Fno.= 3.60 - 3.60 - 3.60

[曲率半径]	[軸上面間隔]	[屈折率(Nd)]	[アッベ数(νd)]
r1* =-14.542			
	d1 = 1.200	N1 = 1.49310	ν1 = 83.58
r2* = 12.397			
	d2 = 1.494		
r3 = ∞			
	d3 = 7.000	N2 = 1.84666	ν2 = 23.82
r4 = ∞			
	d4 = 22.039 - 8.570 - 0.600		

r5* = 7.238

d5 = 2.651　N3 = 1.71300　ν3 = 53.93

r6 = 48.781

d6 = 0.677

r7 = ∞

d7 = 0.600 - 0.931 - 1.000

r8* = 25.723

d8 = 0.805　N4 = 1.84666　ν4 = 23.82

r9* = 10.714

d9 = 6.475 - 16.205 - 14.774

r10 = 42.281

d10 = 2.322　N5 = 1.49310　ν5 = 83.58

r11 = -13.537

d11 = 4.243 - 7.651 - 16.983

r12 = 19.872

d12 = 0.800　N6 = 1.84666　ν6 = 23.82

r13 = 8.858

d13 = 0.100

r14 = 6.329

d14 = 2.301　N7 = 1.48749　ν7 = 70.44

r15* = 16.784

d15 = 0.996

r16 = ∞

d16 = 2.000　N8 = 1.51680　ν2 = 64.20

r17 = ∞

[非球面係数]

r1*

ε = 0.10000E+01

A4 = 0.31440E-03

A6 = 0.40741E-05

A8 = -0.13254E-06

A10= 0.88372E-09

r2*

ε = 0.10000E+01

A4 = -0.14549E-03

A6 = 0.90366E-05

A8 = 0.23593E-06

A10= -0.68590E-08

r8*

ε = 0.10000E+01

A4 = 0.60518E-03

A6 = 0.22274E-04

A8 = -0.54357E-05

A10= 0.24817E-06

r9*

ε = 0.10000E+01

A4 = 0.13444E-02

A6 = 0.68972E-04

A8 = -0.94129E-05

A10= -0.53475E-06

r15*

ε = 0.10000E+01

A4 = 0.12639E-02

A6 = -0.11077E-04

A8 = 0.48956E-05

A10= -0.16001E-06

Drawing 10 thru/or drawing 18 are the aberration Figs. of an example 1 - an example 9, and expresses the aberration in the infinite distance focus condition of the zoom lens system of each example. among drawing 10 thru/or drawing 18 , the shortest focal distance condition and (M) can be set in the middle focal distance condition, and (W) can set (T) in the longest focal distance condition -- many -- astigmatism and distortion aberration, such as spherical aberration, and Y' (mm) show maximum image quantity (considerable from optical axis to distance)} on an image sensor sequentially from the aberration {left. In the spherical-aberration Fig., spherical aberration [as opposed to d line in a continuous line (d)], spherical aberration [as opposed to g line in an alternate long and short dash line (g)], spherical aberration [as opposed to c line in a two-dot chain line (c)], and a broken line (SC) express sine condition. In the

astigmatism Fig., a broken line (DM) expresses the astigmatism in a meridional side, and the continuous line (DS) expresses the astigmatism in a sagittal side. Moreover, in the distortion aberration Fig., the continuous line expresses distortion % to d line.

[0078]

[Effect of the Invention]

Compact image pick-up equipment can be offered it being highly efficient and having a high scale-factor zoom lens system according to the zoom lens system of each operation gestalt, as explained above.

[Brief Description of the Drawings]

[Drawing 1] The lens block diagram of the 1st operation gestalt (example 1).

[Drawing 2] The lens block diagram of the 2nd operation gestalt (example 2).

[Drawing 3] The lens block diagram of the 3rd operation gestalt (example 3).

[Drawing 4] The lens block diagram of the 4th operation gestalt (example 4).

[Drawing 5] The lens block diagram of the 5th operation gestalt (example 1).

[Drawing 6] The lens block diagram of the 6th operation gestalt (example 2).

[Drawing 7] The lens block diagram of the 7th operation gestalt (example 3).

[Drawing 8] The lens block diagram of the 8th operation gestalt (example 4).

[Drawing 9] The lens block diagram of the 9th operation gestalt (example 4).

[Drawing 10] The aberration Fig. in the infinite distance focus condition of an example 1.

[Drawing 11] The aberration Fig. in the infinite distance focus condition of an example 2.

[Drawing 12] The aberration Fig. in the infinite distance focus condition of an example 3.

[Drawing 13] The aberration Fig. in the infinite distance focus condition of an example 4.

[Drawing 14] The aberration Fig. in the infinite distance focus condition of an example 5.

[Drawing 15] The aberration Fig. in the infinite distance focus condition of an example 6.

[Drawing 16] The aberration Fig. in the infinite distance focus condition of an example 7.

[Drawing 17] The aberration Fig. in the infinite distance focus condition of an example 8.

[Drawing 18] The aberration Fig. in the infinite distance focus condition of an

example 9.

[Drawing 19] The block diagram showing the outline of this invention.

[Description of Notations]

LPF: The plane-parallel plate equivalent to an optical low pass filter

SR: Image sensor

TL: Zoom lens system

Gr1: The 1st lens group Gr1

Gr2: The 2nd lens group Gr2

PR: Internal reflection prism

ST: Diaphragm

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] The lens block diagram of the 1st operation gestalt (example 1).

[Drawing 2] The lens block diagram of the 2nd operation gestalt (example 2).

[Drawing 3] The lens block diagram of the 3rd operation gestalt (example 3).

[Drawing 4] The lens block diagram of the 4th operation gestalt (example 4).

[Drawing 5] The lens block diagram of the 5th operation gestalt (example 1).

[Drawing 6] The lens block diagram of the 6th operation gestalt (example 2).

[Drawing 7] The lens block diagram of the 7th operation gestalt (example 3).

[Drawing 8] The lens block diagram of the 8th operation gestalt (example 4).

[Drawing 9] The lens block diagram of the 9th operation gestalt (example 4).

[Drawing 10] The aberration Fig. in the infinite distance focus condition of an

example 1.

[Drawing 11] The aberration Fig. in the infinite distance focus condition of an example 2.

[Drawing 12] The aberration Fig. in the infinite distance focus condition of an example 3.

[Drawing 13] The aberration Fig. in the infinite distance focus condition of an example 4.

[Drawing 14] The aberration Fig. in the infinite distance focus condition of an example 5.

[Drawing 15] The aberration Fig. in the infinite distance focus condition of an example 6.

[Drawing 16] The aberration Fig. in the infinite distance focus condition of an example 7.

[Drawing 17] The aberration Fig. in the infinite distance focus condition of an example 8.

[Drawing 18] The aberration Fig. in the infinite distance focus condition of an example 9.

[Drawing 19] The block diagram showing the outline of this invention.

[Description of Notations]

LPF: The plane-parallel plate equivalent to an optical low pass filter

SR: Image sensor

TL: Zoom lens system

Gr1: The 1st lens group Gr1

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ST: Diaphragm

(19)日本国特許庁(JP)　(12)公開特許公報(A)　(11)特許出願公開番号
特開2004-37925
(P2004-37925A)
(43)公開日　平成16年2月5日(2004.2.5)

(51)Int.Cl.[7]	F I		テーマコード（参考）
G02B 15/20	G02B 15/20		2H083
G02B 13/18	G02B 13/18		2H087
G02B 15/16	G02B 15/16		5C022
G03B 11/00	G03B 11/00		
H04N 5/225	H04N 5/225	D	

審査請求 未請求　請求項の数 5　ＯＬ　（全 41 頁）　最終頁に続く

(21)出願番号　特願2002-196169(P2002-196169)
(22)出願日　平成14年7月4日(2002.7.4)

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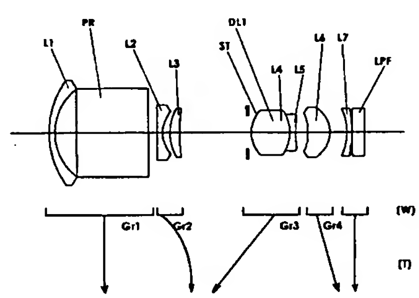
最終頁に続く

(54)【発明の名称】撮像装置

(57)【要約】
【課題】高性能で高倍率ズームレンズ系を備えながら、コンパクトな、撮像装置を提供する。
【解決手段】複数のレンズ群を有し、該複数のレンズ群間の間隔を変化させることによって物体の光学像を連続的に光学的に変倍可能に形成するズームレンズ系と、ズームレンズ系が形成した光学像を電気信号に変換する撮像素子を備えた撮像装置であって、前記ズームレンズ系は、物体側から順に、全体として負のパワーを有し、光束を略９０°折り曲げる反射面を含む第１レンズ群と、前記第１レンズ群との間に変化可能な空気間隔を隔てて配置され、パワーを有する第２レンズ群と、を含み、前記第１レンズ群は、物体側から順に、負のパワーを有する負レンズ素子と、反射面と、からなる。
【選択図】　図１



【特許請求の範囲】
【請求項１】
複数のレンズ群を有し、該複数のレンズ群間の間隔を変化させることによって物体の光学像を連続的に光学的に変倍可能に形成するズームレンズ系と、ズームレンズ系が形成した光学像を電気信号に変換する撮像素子を備えた撮像装置であって、
前記ズームレンズ系は、物体側から順に、
全体として負のパワーを有し、光束を略９０°折り曲げる反射面を含む第１レンズ群と、
前記第１レンズ群との間に変化可能な空気間隔を隔てて配置され、パワーを有する第２レンズ群と、を含み、
前記第１レンズ群は、物体側から順に、負のパワーを有する負レンズ素子と、反射面と、からなることを特徴とする撮像装置。
【請求項２】
前記ズームレンズ系の第１レンズ群が、物体側から順に、負のパワーを有する第１レンズ素子及び反射面から構成されていることを特徴とする請求項１記載の撮像装置。
【請求項３】
前記ズームレンズ系の第１レンズ群が、変倍に際して像面に対して固定されていることを特徴とする請求項１乃至３のいずれかに記載の撮像装置。
【請求項４】
前記ズームレンズ系の最も像側の面と、前記撮像素子との間に、光学的ローパスフィルタを配置していることを特徴とする請求項１乃至３のいずれかに記載の撮像装置。
【請求項５】
請求項１乃至４のいずれかの撮像装置を備えたデジタルカメラ。
【発明の詳細な説明】
【０００１】
【発明が属する技術分野】
本発明は、ＣＣＤ（Ｃｈａｒｇｅ　Ｃｏｕｐｌｅｄ　Ｄｅｖｉｃｅ　電荷結合素子）やＣＭＯＳセンサ（Ｃｏｍｐｌｅｍｅｎｔａｒｙ　Ｍｅｔａｌ－ｏｘｉｄｅ　Ｓｅｍｉｃｏｎｄｕｃｔｏｒ　相補性金属酸化膜半導体センサ）等の受光面上に形成された光学像を電気信号に変換する撮像素子を備えた撮像装置に関し、特にデジタルカメラ；パーソナルコンピュータ，モバイルコンピュータ，携帯電話，情報携帯端末（ＰＤＡ：Ｐｅｒｓｏｎａｌ　Ｄｉｇｉｔａｌ　Ａｓｓｉｓｔａｎｃｅ）等に内蔵又は外付けされるカメラの主たる構成要素である撮像装置に関するものである。詳しくは、特にズームレンズ系を備えた小型の撮像装置に関する。
【０００２】
【従来の技術】
近年、銀塩フィルムの代わりにＣＣＤやＣＭＯＳセンサなどの撮像素子を用いて、光学像を電気信号に変換し、そのデータをデジタル化して記録したり転送したりするデジタルカメラが急速に普及してきている。このようなデジタルカメラにおいては、最近、２００万画素や３００万画素といった高画素を有するＣＣＤやＣＭＯＳセンサが比較的安価に提供されるようになったため、撮像素子を装着した高性能な撮像装置に対する需要が非常に増大しているおり、特に、画質を劣化させずに変倍が可能なズームレンズ系を搭載したコンパクトな撮像装置が切望されている。
【０００３】
さらに、近年では、半導体素子等の画像処理能力の向上により、パーソナルコンピュータ，モバイルコンピュータ，携帯電話，情報携帯端末（ＰＤＡ：Ｐｅｒｓｏｎａｌ　Ｄｉｇｉｔａｌ　Ａｓｓｉｓｔａｎｃｅ）等に撮像装置が内蔵又は外付けされるようになっており、高性能な撮像装置に対する需要に拍車をかけている。
【０００４】
このような撮像装置に用いられるズームレンズ系としては、最も物体側に配置されたレンズ群が負のパワーを有する、いわゆるマイナスリードのズームレンズ系が数多く提案され

ている。マイナスリードのズームレンズ系は、広角化が容易であり、光学的ローパスフィルタの挿入に必要なレンズバックを確保しやすい等の特徴を有している。

【０００５】

マイナスリードのズームレンズ系としては、従来から銀塩フィルム用カメラの撮影レンズ系として提案されたズームレンズ系がある。しかしながら、これらのズームレンズ系は、特に最短焦点距離状態でのレンズ系の射出瞳位置が比較的像面の近くに位置するため、特に高画素を有する撮像素子の各画素に対応して設けられたマイクロレンズの瞳と整合せず、周辺光量が十分に確保できないという問題があった。また、変倍時に射出瞳位置が大きく変動するため、マイクロレンズの瞳の設定が困難であるという問題もあった。また、そもそも銀塩フィルムと撮像素子では、求められる空間周波数特性等の光学性能が全く異なるため、撮像素子に要求される十分な光学性能を確保できなかった。このため、撮像素子を備えた撮像装置に最適化された専用のズームレンズ系を開発する必要が生じている。

【０００６】

一方、撮像装置を小型化するために、ズームレンズ系を光路の途中で折り曲げ、光路長を変化させずにコンパクト化を図かる提案が成されている。例えば、特開平１１－１９６３０３号公報には、マイナスリードのズームレンズ系において、光路上に反射面を設けて略９０°折り曲げた後、移動レンズ群を経て撮像素子上に光学像を形成する撮像装置が提案されている。同公報開示の撮像装置は、負メニスカス形状の固定レンズ素子の像側に反射面を設け、この反射面で光路を略９０°折り曲げた後、可動の２つの正レンズ群、固定の正レンズ群を経て撮像素子に至る構成を有している。

【０００７】

また別の例として、特開平１１－２５８６７８号公報には、負メニスカス形状の固定レンズ素子、可動の正レンズ群の像側に反射面を設け、この反射面で光路を略９０°折り曲げた後、正レンズ群を経て撮像素子に至る構成が開示されている。

【０００８】

【発明が解決しようとする課題】

しかしながら、上記２つの公報においては、鏡胴の構成のみしか開示されておらず、具体的なズームレンズ系の構成が不明であるという問題があった。ズームレンズ系を備えた撮像装置では、体積的に最も大きな空間を占めるズームレンズ系を最適化しない限り、全体の小型化を達成することは困難である。

【０００９】

本発明は、以上の課題に鑑み、高性能で高倍率ズームレンズ系を備えながら、コンパクトな、撮像装置を提供することを目的とする。

【００１０】

【課題を解決するための手段】

上記課題を解決するために、本発明に係る撮像装置は、複数のレンズ群を有し、該複数のレンズ群間の間隔を変化させることによって物体の光学像を連続的に光学的に変倍可能に形成するズームレンズ系と、ズームレンズ系が形成した光学像を電気信号に変換する撮像素子を備えた撮像装置であって、前記ズームレンズ系は、物体側から順に、全体として負のパワーを有し、光束を略９０°折り曲げる反射面を含む第１レンズ群と、前記第１レンズ群との間に変化可能な空気間隔を隔てて配置され、パワーを有する第２レンズ群と、を含み、前記第１レンズ群は、物体側から順に、負のパワーを有する負レンズ素子と、反射面と、からなることを特徴とする。

【００１１】

また、本発明の別の側面は、上記撮像装置を含むデジタルカメラであることを特徴とする。なお、デジタルカメラの語は、従来は専ら光学的な静止画を記録するものを指していたが、動画を同時に扱えるものや家庭用のデジタルビデオカメラも提案されており、現在では特に区別されなくてなってきている。したがって、以下、デジタルカメラの語は、デジタルスチルカメラやデジタルムービー等の撮像素子の受光面上に形成された光学像を電気信号に変換する撮像素子を備えた撮像装置を主たる構成要素とするカメラをすべて含むも

のとする。
【００１２】
【発明の実施の形態】
以下、図面を参照して、本発明の一実施形態について説明する。
【００１３】
本発明の一実施形態である撮像装置は、例えば図１９に示すように、物体側（被写体側）から順に、物体の光学像を変倍可能に形成するズームレンズ系とＴＬ、光学的ローパスフィルタＬＰＦと、ズームレンズ系ＴＬにより形成された光学像を電気的な信号に変換する撮像素子ＳＲと、で構成されている。また、ズームレンズ系は、内部に反射面を有するプリズムＰＲを有する第１レンズ群Ｇｒ１と、後続するレンズ群を含んでいる。撮像装置は、デジタルカメラ；ビデオカメラ；パーソナルコンピュータ，モバイルコンピュータ，携帯電話，情報携帯端末（ＰＤＡ：Ｐｅｒｓｏｎａｌ　Ｄｉｇｉｔａｌ　Ａｓｓｉｓｔａｎｃｅ）等に内蔵又は外付けされるカメラの主たる構成要素である。
【００１４】
ズームレンズ系ＴＬは、第１レンズ群Ｇｒ１を含む複数のレンズ群から構成されており、各レンズ群の間の間隔を変化させることによって光学像の大きさを変化させることが可能である。第１レンズ群Ｇｒ１は負のパワーを有しており、内部に物体光の光軸を略９０°折り曲げるプリズムＰＲを有する。
【００１５】
光学ローパスフィルタＬＰＦは、撮影レンズ系の空間周波数特性を調整し撮像素子で発生する色モアレを解消するための特定の遮断周波数を有している。実施形態の光学ローパスフィルタは、結晶軸を所定方向に調整された水晶等の複屈折材料や偏光面を変化させる波長板等を積層して作成された複屈折型ローパスフィルタである。なお、光学ローパスフィルタとしては、必要な光学的な遮断周波数の特性を回折効果により達成する位相型ローパスフィルタ等を採用してもよい。
【００１６】
撮像素子ＳＲは、複数の画素を有するＣＣＤからなり、ズームレンズ系が形成した光学像をＣＣＤで電気信号に変換する。撮像素子ＳＲで生成された信号は、必要に応じて所定のデジタル画像処理や画像圧縮処理等を施されてデジタル映像信号としてメモリー（半導体メモリー，光ディスク等）に記録されたり、場合によってはケーブルを介したり赤外線信号に変換されたりして他の機器に伝送される。なお、ＣＣＤの代わりにＣＭＯＳセンサ（Ｃｏｍｐｌｅｍｅｎｔａｒｙ　Ｍｅｔａｌ－ｏｘｉｄｅ　Ｓｅｍｉｃｏｎｄｕｃｔｏｒ）を用いてもよい。
【００１７】
図１乃至図９は、本発明の第１乃至第９実施形態の撮像装置に含まれるズームレンズ系の最短焦点距離状態でのレンズ配置を示す構成図である。なお、各図においては、内部反射面を有するプリズムＰＲを平行平板で表し光路を直線的に表している。
【００１８】
第１の実施形態のズームレンズ系は、物体側から像側へ順に、物体側に凸面を向けた負メニスカスレンズからなる第１レンズ素子Ｌ１とプリズムに相当する平板ＰＲと、から構成される第１レンズ群Ｇｒ１と、両凹形状の第２レンズ素子Ｌ２と物体側に凸面を向けた正メニスカス形状の第３レンズ素子Ｌ３と、から構成される第２レンズ群Ｇｒ２と、絞りＳＴと、両凸形状の第４レンズ素子Ｌ４と両凹形状の第５レンズ素子Ｌ５とを接合してなる第１接合レンズ素子ＤＬ１から構成される第３レンズ群Ｇｒ３と、物体側に凹面を向けた正メニスカス形状の第６レンズ素子Ｌ６から構成される第４レンズ群Ｇｒ４と、物体側に凹面を向けた負メニスカス形状の第７レンズ素子Ｌ７とから構成される第５レンズ群Ｇｒ５と、から構成されている。さらに、このズームレンズ系の第５レンズ群Ｇｒ５の像側には、光学的ローパスフィルタに相当する平行平板ＬＰＦが配置されている。
【００１９】
このズームレンズ系は、最短焦点距離状態から最長焦点距離状態へのズーミングに際して

、第１レンズ群Ｇｒ１は像面に対して固定され、第２レンズ群Ｇｒ２は一旦像側へ移動した後で物体側へ移動するよう像側に凸のＵターン状の軌跡を描いて移動し、第３レンズ群Ｇｒ３は、第３レンズ群Ｇｒ３の物体側に配置された絞りＳＴと一体となりほぼ単調に物体側へ移動し、第４レンズ群Ｇｒ４はほぼ単調に像側へ移動し、第５レンズ群Ｇｒ５は、第５レンズ群Ｇｒ５の像側に配置された平行平板ＬＰＦとともに、像面に対して固定されている。

【００２０】

レンズ素子の面のうち、第２レンズ素子Ｌ２の両面と、第６レンズ素子Ｌ６の像側面と、第７レンズ素子Ｌ７の物体側面は、それぞれ非球面形状を有している。

【００２１】

第２の実施形態のズームレンズ系は、物体側から像側へ順に、物体側に凸面を向けた負メニスカスレンズからなる第１レンズ素子Ｌ１、プリズムに相当する平板ＰＲ、物体側に凸面を向けた正メニスカス形状の第２レンズ素子Ｌ２とから構成される第１レンズ群Ｇｒ１と、物体側に凸面を向けた負メニスカス形状の第３レンズ素子Ｌ３と物体側に凸面を向けた正メニスカス形状の第４レンズ素子Ｌ４と、から構成される第２レンズ群Ｇｒ２と、絞りＳＴと、両凸形状の第５レンズ素子Ｌ５と両凹形状の第６レンズ素子Ｌ６とを接合してなる第１接合レンズ素子ＤＬ１から構成される第３レンズ群Ｇｒ３と、物体側に凹面を向けた正メニスカス形状の第７レンズ素子Ｌ７から構成される第４レンズ群Ｇｒ４と、物体側に凸面を向けた負メニスカス形状の第８レンズ素子Ｌ８とから構成される第５レンズ群Ｇｒ５と、から構成されている。さらに、このズームレンズ系の第５レンズ群Ｇｒ５の像側には、光学的ローパスフィルタに相当する平行平板ＬＰＦが配置されている。

【００２２】

このズームレンズ系は、最短焦点距離状態から最長焦点距離状態へのズーミングに際して、第１レンズ群Ｇｒ１は像面に対して固定され、第２レンズ群Ｇｒ２は一旦像側へ移動した後で物体側へ移動するよう像側に凸のＵターン状の軌跡を描いて移動し、第３レンズ群Ｇｒ３は、第３レンズ群Ｇｒ３の物体側に配置された絞りＳＴと一体となりほぼ単調に物体側へ移動し、第４レンズ群Ｇｒ４はほぼ単調に像側へ移動し、第５レンズ群Ｇｒ５は、第５レンズ群Ｇｒ５の像側に配置された平行平板ＬＰＦとともに、像面に対して固定されている。

【００２３】

レンズ素子の面のうち、第１レンズ素子Ｌ１の物体側面、第３レンズ素子Ｌ３の両面、第７レンズ素子Ｌ７の像側面、第８レンズ素子Ｌ８の物体側面は、それぞれ非球面形状を有している。

【００２４】

第３の実施形態のズームレンズ系は、物体側から像側へ順に、物体側に凸面を向けた負メニスカスレンズからなる第１レンズ素子Ｌ１とプリズムに相当する平板ＰＲと、から構成される第１レンズ群Ｇｒ１と、物体側に凸面を向けた負メニスカス形状の第２レンズ素子Ｌ２と物体側に凸面を向けた正メニスカス形状の第３レンズ素子Ｌ３と、から構成される第２レンズ群Ｇｒ２と、絞りＳＴと、両凸形状の第４レンズ素子Ｌ４と両凹形状の第５レンズ素子Ｌ５とを接合してなる第１接合レンズ素子ＤＬ１から構成される第３レンズ群Ｇｒ３と、物体側に凹面を向けた正メニスカス形状の第６レンズ素子Ｌ６から構成される第４レンズ群Ｇｒ４と、物体側に凸面を向けた負メニスカス形状の第７レンズ素子Ｌ７とから構成される第５レンズ群Ｇｒ５と、から構成されている。さらに、このズームレンズ系の第５レンズ群Ｇｒ５の像側には、光学的ローパスフィルタに相当する平行平板ＬＰＦが配置されている。

【００２５】

このズームレンズ系は、最短焦点距離状態から最長焦点距離状態へのズーミングに際して、第１レンズ群Ｇｒ１は像面に対して固定され、第２レンズ群Ｇｒ２は一旦像側へ移動した後で物体側へ移動するよう像側に凸のＵターン状の軌跡を描いて移動し、第３レンズ群Ｇｒ３は、第３レンズ群Ｇｒ３の物体側に配置された絞りＳＴと一体となりほぼ単調に物

体側へ移動し、第４レンズ群Ｇｒ４はほぼ単調に像側へ移動し、第５レンズ群Ｇｒ５は、第５レンズ群Ｇｒ５の像側に配置された平行平板ＬＰＦとともに、像面に対して固定されている。

【００２６】
レンズ素子の面のうち、第２レンズ素子Ｌ２の両面と、第５レンズ素子Ｌ５の像側面と、第６レンズ素子Ｌ６の両面は、それぞれ非球面形状を有している。

【００２７】
第４の実施形態のズームレンズ系は、物体側から像側へ順に、物体側に凸面を向けた負メニスカスレンズからなる第１レンズ素子Ｌ１とプリズムに相当する平板ＰＲと、から構成される第１レンズ群Ｇｒ１と、物体側に凸面を向けた負メニスカス形状の第２レンズ素子Ｌ２と物体側に凸面を向けた正メニスカス形状の第３レンズ素子Ｌ３と、から構成される第２レンズ群Ｇｒ２と、絞りＳＴと、両凸形状の第４レンズ素子Ｌ４と、物体側に凹面を向けた正メニスカス形状の第５レンズ素子Ｌ５と物体側に凹面を向けた負メニスカス形状の第６レンズ素子Ｌ６を接合してなる第１接合レンズ素子ＤＬ１から構成される第３レンズ群Ｇｒ３と、両凸形状の第７レンズ素子Ｌ７から構成される第４レンズ群Ｇｒ４と、から構成されている。さらに、このズームレンズ系の第４レンズ群Ｇｒ４の像側には、光学的ローパスフィルタに相当する平行平板ＬＰＦが配置されている。

【００２８】
このズームレンズ系は、最短焦点距離状態から最長焦点距離状態へのズーミングに際して、第１レンズ群Ｇｒ１は像面に対して固定され、第２レンズ群Ｇｒ２は一旦像側へ移動し後で物体側へ移動するよう像側に凸のＵターン状の軌跡を描いて移動し、第３レンズ群Ｇｒ３　　は、第３レンズ群Ｇｒ３の物体側に配置された絞りＳＴと一体となりほぼ単調に物体側へ移動し、第４レンズ群Ｇｒ４はほぼ単調に像側へ移動し、平行平板ＬＰＦは像面に対して固定されている。

【００２９】
レンズ素子の面のうち、第２レンズ素子Ｌ２の両面と、第６レンズ素子Ｌ６の像側面と、第７レンズ素子Ｌ７の両面は、それぞれ非球面形状を有している。

【００３０】
第５の実施形態のズームレンズ系は、物体側から像側へ順に、物体側に凹面を向けた負メニスカスレンズからなる第１レンズ素子Ｌ１とプリズムに相当する平板ＰＲと、から構成される第１レンズ群Ｇｒ１と、物体側に凸面を向けた負メニスカス形状の第２レンズ素子Ｌ２と物体側に凸面を向けた正メニスカス形状の第３レンズ素子Ｌ３と、から構成される第２レンズ群Ｇｒ２と、絞りＳＴと、両凸形状の第４レンズ素子Ｌ４と両凹形状の第５レンズ素子Ｌ５とを接合してなる第１接合レンズ素子ＤＬ１から構成される第３レンズ群Ｇｒ３と、物体側に凸面を向けた正メニスカス形状の第６レンズ素子Ｌ６から構成される第４レンズ群Ｇｒ４と、から構成されている。さらに、このズームレンズ系の第４レンズ群Ｇｒ４の像側には、光学的ローパスフィルタに相当する平行平板ＬＰＦが配置されている。

【００３１】
このズームレンズ系は、最短焦点距離状態から最長焦点距離状態へのズーミングに際して、第１レンズ群Ｇｒ１は像面に対して固定され、第２レンズ群Ｇｒ２は一旦像側へ移動した後で物体側へ移動するよう像側に凸のＵターン状の軌跡を描いて移動し、第３レンズ群Ｇｒ３は、第３レンズ群Ｇｒ３の物体側に配置された絞りＳＴと一体となりほぼ単調に物体側へ移動し、第４レンズ群Ｇｒ４はほぼ単調に像側へ移動し、平行平板ＬＰＦは像面に対して固定されている。

【００３２】
レンズ素子の面のうち、第２レンズ素子Ｌ２の両面と、第５レンズ素子Ｌ５の像側面と、第６レンズ素子Ｌ６の両面は、それぞれ非球面形状を有している。

【００３３】
第６の実施形態のズームレンズ系は、物体側から像側へ順に、物体側に凸面を向けた負メ

ニスカスレンズからなる第１レンズ素子Ｌ１、プリズムに相当する平板ＰＲと、物体側に凸面を向けた負メニスカス形状の第２レンズ素子Ｌ２、物体側に凸面を向けた正メニスカス形状の第３レンズ素子Ｌ３、から構成される第１レンズ群Ｇｒ１と、絞りＳＴと、両凸形状の第４レンズ素子Ｌ４と両凹形状の第５レンズ素子Ｌ５とを接合してなる第１接合レンズ素子ＤＬ１から構成される第２レンズ群Ｇｒ２と、物体側に凹面を向けた負メニスカス形状の第６レンズ素子Ｌ６から構成される第４レンズ群Ｇｒ４と、物体側に凹面を向けた負メニスカス形状の第７レンズ素子Ｌ７から構成される第７レンズ群Ｇｒ５と、から構成されている。さらに、このズームレンズ系の第４レンズ群Ｇｒ４の像側には、光学的ローパスフィルタに相当する平行平板ＬＰＦが配置されている。

【００３４】
このズームレンズ系は、最短焦点距離状態から最長焦点距離状態へのズーミングに際して、第１レンズ群Ｇｒ１は一旦像側へ移動した後で物体側へ移動するよう像側に凸のＵターン状の軌跡を描いて移動し、第２レンズ群Ｇｒ２は、第２レンズ群Ｇｒ２の物体側に配置された絞りＳＴと一体となりほぼ単調に物体側へ移動し、第３レンズ群Ｇｒ３はほぼ単調に像側へ移動し、第４レンズ群Ｇｒ４は平行平板ＬＰＦとともに像面に対して固定されている。

【００３５】
レンズ素子の面のうち、第２レンズ素子Ｌ２の両面と、第５レンズＬ５の像側面と、第６レンズ素子Ｌ６の物体側面と、それぞれ非球面形状を有している。

【００３６】
第７の実施形態のズームレンズ系は、物体側から像側へ順に、両凹形状の第１レンズ素子Ｌ１、プリズムに相当する平板ＰＲとから構成される第１レンズ群Ｇｒ１と、物体側に凸面を向けた正メニスカス形状の第２レンズ素子Ｌ２と物体側に凸面を向けた負メニスカス形状の第３レンズ素子Ｌ３と、から構成される第２レンズ群Ｇｒ２と、この第２レンズ素子Ｌ２と第３レンズ素子Ｌ３の間に配置された絞りＳＴと、両凸形状の第４レンズ素子Ｌ４から構成される第３レンズ群Ｇｒ３と、物体側に凸面を向けた負メニスカス形状の第５レンズ素子Ｌ５と、両凸形状の第６レンズ素子Ｌ６から構成される第４レンズ群Ｇｒ４と、から構成される。さらに、このズームレンズ系の第４レンズ群Ｇｒ４の像側には、光学的ローパスフィルタに相当する平行平板ＬＰＦが配置されている。

【００３７】
このズームレンズ系は、最短焦点距離状態から最長焦点距離状態へのズーミングに際して、第１レンズ群Ｇｒ１は像面に対して固定され、第２レンズ群Ｇｒ２は、ほぼ単調に物体側へ移動し、第３レンズ群Ｇｒ３は絞りＳＴと一体となりほぼ単調に物体側へ移動し、第４レンズ群Ｇｒ４は平行平板ＬＰＦとともに像面に対して固定されている。

【００３８】
レンズ素子の面のうち、第１レンズ素子Ｌ１の両面と、第２レンズ素子Ｌ２の物体側面、第３レンズＬ３の両面と、第６レンズ素子Ｌ６の像側面と、それぞれ非球面形状を有している。

【００３９】
第８の実施形態のズームレンズ系は、物体側から像側へ順に、両凹形状の第１レンズ素子Ｌ１、プリズムに相当する平板ＰＲとから構成される第１レンズ群Ｇｒ１と、物体側に凸面を向けた正メニスカス形状の第２レンズ素子Ｌ２と物体側に凸面を向けた負メニスカス形状の第３レンズ素子Ｌ３と、から構成される第２レンズ群Ｇｒ２と、この第２レンズ素子Ｌ２と第３レンズ素子Ｌ３の間に配置された絞りＳＴと、両凸形状の第４レンズ素子Ｌ４から構成される第３レンズ群Ｇｒ３と、物体側に凹面を向けた負メニスカス形状の第５レンズ素子Ｌ５と、両凸形状の第６レンズ素子Ｌ６から構成される第４レンズ群Ｇｒ４と、から構成される。さらに、このズームレンズ系の第４レンズ群Ｇｒ４の像側には、光学的ローパスフィルタに相当する平行平板ＬＰＦが配置されている。

【００４０】
このズームレンズ系は、最短焦点距離状態から最長焦点距離状態へのズーミングに際して

、第１レンズ群Ｇｒ１は像面に対して固定され、第２レンズ群Ｇｒ２は、物体側に凸の軌跡を描きながら絞りＳＴと一体となり物体側へ移動し、第３レンズ群Ｇｒ３はほぼ単調に物体側へ移動し、第４レンズ群Ｇｒ４はほぼ単調に像側へ移動し、平行平板ＬＰＦは像面に対して固定されている。

【００４１】

このズームレンズ系は、最短焦点距離状態から最長焦点距離状態へのズーミングに際して、第１レンズ群Ｇｒ１は一旦像側へ移動した後で物体側へ移動するよう像側に凸のＵターン状の軌跡を描いて移動し、第２レンズ群Ｇｒ２は、第２レンズ群Ｇｒ２の物体側に配置された絞りＳＴと一体となりほぼ単調に物体側へ移動し、第３レンズ群Ｇｒ３はほぼ単調に像側へ移動し、第４レンズ群Ｇｒ４は平行平板ＬＰＦとともに像面に対して固定されている。

【００４２】

レンズ素子の面のうち、第１レンズ素子Ｌ１の両面と、第２レンズ素子Ｌ２の物体側面、第３レンズＬ３の両面と、第６レンズ素子Ｌ６の像側面と、それぞれ非球面形状を有している。

【００４３】

第９の実施形態のズームレンズ系は、物体側から像側へ順に、両凹形状の第１レンズ素子Ｌ１、プリズムに相当する平板ＰＲとから構成される第１レンズ群Ｇｒ１と、物体側に凸面を向けた正メニスカス形状の第２レンズ素子Ｌ２から構成される第２レンズ群Ｇｒ２と、絞りＳＴと、物体側に凸面を向けた負メニスカス形状の第３レンズ素子Ｌ３から構成される第３レンズ群Ｇｒ３と、両凸形状の第４レンズ素子Ｌ４から構成される第４レンズ群Ｇｒ４と、物体側に凸面を向けた負メニスカス形状の第５レンズ素子Ｌ５、物体側に凸面を向けた正メニスカス形状の第６レンズ素子Ｌ６から構成される第５レンズ群Ｇｒ５と、から構成される。さらに、このズームレンズ系の第５レンズ群Ｇｒ５の像側には、光学的ローパスフィルタに相当する平行平板ＬＰＦが配置されている。

【００４４】

このズームレンズ系は、最短焦点距離状態から最長焦点距離状態へのズーミングに際して、第１レンズ群Ｇｒ１は像面に対して固定され、第２レンズ群Ｇｒ２は、物体側に凸の軌跡を描きながら絞りＳＴと一体となり物体側へ移動し、第３レンズ群Ｇｒ３はほぼ単調に物体側へ移動し、第４レンズ群Ｇｒ４はほぼ単調に物体側へ移動し、第５レンズ群Ｇｒ５は平行平板ＬＰＦとともに像面に対して固定されている。

【００４５】

レンズ素子の面のうち、第１レンズ素子Ｌ１の両面と、第２レンズ素子Ｌ２の物体側面、第３レンズＬ３の両面と、第６レンズ素子Ｌ６の像側面と、それぞれ非球面形状を有している。

【００４６】

各実施形態のズームレンズ系は、第１群内部に物体光の光軸を略９０°折り曲げる反射面を持つようリズムＰＲを備えている。このように、物体光の光軸を略９０°折り曲げることにより、撮像装置の見かけ上の薄型化を達成することが可能になる。

【００４７】

デジタルカメラを例に考えた場合、装置中で最も大きな体積を占有するのは、ズームレンズ系を含めた撮像装置である。特に、デジタルカメラで従来のレンズシャッタータイプのフィルムカメラのように、光軸の方向を変更することなくズームレンズ系に含まれるレンズや絞り等の光学要素を直線的に配列した場合、カメラの厚み方向の大きさは、撮像装置に含まれるズームレンズ系の最も物体側の構成から撮像素子までの大きさで事実上決定される。ところが、近年の撮像素子に対する高画素化に伴い、撮像装置の収差補正レベルも飛躍的に向上している。このため、撮像装置に含まれるズームレンズ系のレンズ素子の枚数も増大する一方であり、非使用時（いわゆる沈胴状態）でもレンズ素子の厚みのため薄型を達成することが困難になっている。

【００４８】

これに対し、各実施形態のズームレンズ系のように反射面により物体光の光軸を略９０°折り曲げる構成を採用することにより、非使用時には撮像装置の厚さ方向の大きさを最も物体側のレンズから反射面までの大きさまで小さくすることが可能になるため、撮像装置の見かけ上の薄型化を達成することが可能になるのである。また、反射面により物体光の光軸を略９０°折り曲げる構成を採用することにより、反射面近傍では物体光の光路を重ね合わせることができるため、空間を有効に使用することができ、撮像装置のさらなる小型化を達成することができる。

【００４９】

反射面の位置は、第１レンズ群Ｇｒ１内部であることが望ましい。最も物体側に配置された第１レンズ群Ｇｒ１内部に配置することにより、撮像装置の厚さ方向の大きさを最小にすることが可能になる。

【００５０】

反射面が含まれる第１レンズ群Ｇｒ１は、負のパワーを有することが望ましい。第１レンズ群Ｇｒ１が負のパワーを持つことにより、反射面位置での反射面の大きさを小さくすることが可能になる。また、第１レンズ群Ｇｒ１が負のパワーを有する構成を採用することにより、ズームレンズ系がいわゆるマイナスリードタイプになる。マイナスリードタイプのズームレンズ系は、広い焦点距離領域において、レトロフォーカスタイプの構成をとりやすく、撮像素子に光学像を形成するための光学系に必要な像側テレセントリック性を達成することが容易になり望ましい。

【００５１】

反射面は、（ａ）内部反射プリズム（実施形態）、（ｂ）表面反射プリズム、（Ｃ）内部反射平板ミラー、（ｄ）表面反射ミラー、のいずれを採用してもよいが、（ａ）内部反射プリズムが最適である。内部反射プリズムを採用することにより、物体光がプリズムの媒質中を通過することになるため、プリズムを透過する際の面間隔は、媒質の屈折率に応じて通常の空気間隔よりも物理的な間隔よりも短い換算面間隔になる。このため、反射面の構成として内部反射プリズムを採用した場合、光学的に等価な構成を、よりコンパクトなスペースで達成することができ望ましい。

【００５２】

反射面を内部反射プリズムで構成する場合、プリズムの材質は、以下の条件を満足することが望ましい。

【００５３】

$Np \geqq 1.55$ ・・・・（１）

ただし、

Ｎｐはプリズムの材質の屈折率、

である。

【００５４】

プリズムの屈折率が上記の範囲を下まわると、コンパクト化への寄与が小さくなり好ましくない。

【００５５】

さらに、上記範囲に加えて以下の範囲にあることが好ましい。

【００５６】

$Np \geqq 1.7$ ・・・・（１）’

また、反射面は、完全な全反射面でなくてもよい。反射面のうち一部分の反射率を適宜調整して一部の物体光を分岐するようにし、測光や測距用のセンサに入射させてもよい。さらに、反射面全面の反射率を適宜調整してファインダ光を分岐させてもよい。さらに、各実施形態では、プリズムの入射面と出射面はいずれも平面であるが、パワーを持つ面であってもよい。

【００５７】

反射面より、物体側は１枚のレンズ素子で構成されていることが望ましい。第１群内部に物体光の光軸を略９０°折り曲げる反射面を持つようリズムＰＲを有する構造では、最も

物体側に配置されたレンズの物体側面から反射面までの間隔で、光学系の実質的な厚みが決定されてしまうので、反射面より物体側の構成を、１枚のレンズ素子で構成することにより、薄型の光学系を得ることが可能になる。また、鏡胴構成の自由度を増加させることができ、撮像装置の低コスト化を達成することができる。

【００５８】

さらに、変倍時に第１レンズ群Ｇｒ１は、像面に対して固定であることが望ましい。第１レンズ群Ｇｒ１には反射面が含まれているため、移動させると大きなスペースを必要とするとともに、特に、反射面をプリズムで構成している場合、重量の大きなプリズムを移動させなければならず、駆動機構に大きな負担を強いることになり好ましくない。また、第１レンズ群Ｇｒ１を変倍時に像面に対して固定にすることにより、全長変化しない光学系を得ることができ好ましい。また、鏡胴構成も簡素化することができ、撮像装置全体の低コスト化を達成することが可能になる。さらに、第１レンズ群Ｇｒ１をズーミング時に固定する構成を採用することにより、特にデジタルカメラにおいて、ズーム時移動群のコントロールのための制御系のイニシャライズが簡単になるため、主電源ＯＮ時から撮影可能状態までに必要な時間を短縮することが可能となり望ましい。

【００５９】

各実施形態のズームレンズ系は、負のパワーを有する第１レンズ群Ｇｒ１に続く、第２レンズ群Ｇｒ２も負のパワーとする構成を採用している。この構成により、上記の第１レンズ群を固定にする構成を採用しやすく望ましい。

【００６０】

各実施形態のズームレンズ系は、以下の条件を満足することが望ましい。

【００６１】

次に、各実施の形態が満足することが好ましい条件を説明する。なお、以下の説明する個々の条件をそれぞれ単独に満足すれば、それに対応する作用効果を達成することは可能であるが、複数の条件を満足する方が、光学性能、小型化の観点からより望ましいことはいうまでもない。

【００６２】

各実施形態のズームレンズ系は、以下の条件を満足することが望ましい。

【００６３】

$0.5 < |f1 / f2| < 5$・・・・（２）

ただし、

ｆ１：第１レンズ群Ｇｒ１の焦点距離、

ｆ２：第２レンズ群Ｇｒ２の焦点距離、

である。

【００６４】

条件（２）は、第１レンズ群Ｇｒ１が負のパワーを有し、第２レンズ群Ｇｒ２が負のパワーを有する構成（例えば、実施例１乃至５）において、第１レンズ群Ｇｒ１と第２レンズ群Ｇｒ２の望ましい焦点距離比を規定している。条件（２）の下限を超えると、第１レンズ群Ｇｒ１の焦点距離が短くなりすぎるため、歪曲収差（特に最短焦点距離状態での負の歪曲収差）が著しくなり、良好な光学性能を確保することが困難になる。逆に、条件（２）の上限を超えると、第１レンズ群Ｇｒ１の焦点距離が長くなりすぎるため、第１レンズ群Ｇｒ１の負のパワーが弱くなり、第１レンズ群Ｇｒ１のレンズ径の増大を招くことになり、コンパクト化という点で好ましくない。

【００６５】

さらに、各実施形態のズームレンズ系は、以下の条件を満足することが望ましい。

【００６６】

$1.5 < |f12w| / fw < 4$・・・・（３）

ただし、

ｆ１２ｗ：最短焦点距離状態での第１レンズ群Ｇｒ１と第２レンズ群Ｇｒ２の合成焦点距離、

ｆｗ：全系の最短焦点距離状態での焦点距離、
である。
【００６７】
条件（３）は、第１レンズ群Ｇｒ１が負のパワーを有し、第２レンズ群Ｇｒ２が負のパワーを有する構成（例えば、実施例１乃至５）において、最短焦点距離状態での第１レンズ群Ｇｒ１と第２レンズ群Ｇｒ２の合成焦点距離に関する条件である。条件（３）の上限を超えると、第１レンズ群Ｇｒ１、第２レンズ群Ｇｒ２の合成焦点距離が長くなりすぎるので全長が増大するとともに、第１レンズ群Ｇｒ１、第２レンズ群Ｇｒ２の合成パワーが弱くなるのでレンズ径が大きくなる。したがって、コンパクトなズームレンズ系を得ることが困難になる。逆に、条件（３）の下限を超えると、第１レンズ群Ｇｒ１、第２レンズ群Ｇｒ２の合成焦点距離が短くなりすぎるので、最短焦点距離状態で第１レンズ群Ｇｒ１と第２レンズ群Ｇｒ２で発生する負の歪曲収差が大きくなりすぎて補正が困難になる。
【００６８】
さらに、各実施形態のズームレンズ系は、以下の条件を満足することが望ましい。
【００６９】
$0.4 < |f12w| / f3 < 1.5$ ・・・・（４）
ただし、
ｆ１２ｗ：最短焦点距離状態での第１レンズ群Ｇｒ１と第２レンズ群Ｇｒ２の合成焦点距離、
ｆ３：第３レンズ群Ｇｒ３の焦点距離、
である。
【００７０】
条件（４）は、第１レンズ群Ｇｒ１が負のパワーを有し、第２レンズ群Ｇｒ２が負のパワーを有する構成（例えば、実施例１乃至５）において、最短焦点距離状態での第１レンズ群Ｇｒ１と第２レンズ群Ｇｒ２の合成焦点距離と第３レンズ群の焦点距離の比に関する条件である。条件（４）の上限を超えると、第１レンズ群Ｇｒ１、第２レンズ群Ｇｒ２の合成焦点距離が相対的に長くなることを意味している。このため、条件（４）の上限を超えると、射出瞳位置が像側に移動することになり好ましくない。逆に、条件（３）の下限を超えると、第１レンズ群Ｇｒ１、第２レンズ群Ｇｒ２の合成焦点距離が短くなりすぎるので、最短焦点距離状態で第１レンズ群Ｇｒ１と第２レンズ群Ｇｒ２で発生する負の歪曲収差が大きくなりすぎて補正が困難になる。
【００７１】
$2 < |f1 / fw| < 4$　　（５）
ただし、
ｆ１：第１レンズ群の焦点距離、
ｆｗ：全系の広角端での焦点距離、
である。
【００７２】
条件式（５）は、第１レンズ群Ｇｒ１が負のパワーを有し、第２レンズ群Ｇｒ２が正のパワーを有する構成（例えば、実施例６乃至９）において、第１レンズ群Ｇｒ１の望ましい焦点距離を規定している。条件式（５）の上限を超えると、第１レンズ群Ｇｒ１の焦点距離が大きくなりすぎるので、結果として全長あるいは反射面から撮像素子までの距離を小さくすることができず望ましくない。また、第１レンズ群Ｇｒ１の負のパワーが弱くなりすぎるので第１レンズ群Ｇｒ１を構成するレンズ外径が大きくなりコンパクトなズームレンズ系を達成することができなくなる。逆に条件式（５）の下限を超えると、第１レンズ群Ｇｒ１の焦点距離が短くなりすぎるので、広角端において第１レンズ群Ｇｒ１で発生する負の歪曲が大きくなりすぎ、その補正を行うことが困難になる。
【００７３】
各実施形態を構成している各レンズ群は、入射光線を屈折により偏向させる屈折型レンズ（つまり、異なる屈折率を有する媒質同士の界面で偏向が行われるタイプのレンズ）のみ

で構成されているが、これに限られない。例えば、回折により入射光線を偏向させる回折型レンズ，回折作用と屈折作用との組合わせにより入射光線を偏向させる屈折・回折ハイブリッド型レンズ，入射光線を媒質内の屈折率分布により偏向させる屈折率分布レンズ等で、各レンズ群を構成してもよい。

【００７４】

【実施例】

以下、本発明を実施した撮像装置に含まれるズームレンズ系の構成等を、コンストラクションデータ，収差図等を挙げて、更に具体的に説明する。ここで実施例として説明する実施例１乃至４は、前述した第１乃至第９の実施形態にそれぞれ対応しており第１乃至第９の実施形態を表すレンズ構成図（図１乃至９）は、対応する実施例１乃至９のレンズ構成をそれぞれ示している。

【００７５】

各実施例のコンストラクションデータにおいて、ｒｉ　（ｉ　＝　１，２，３．．．．）は物体側から数えてｉ番目の面の曲率半径（ｍｍ）、ｄｉ　（ｉ　＝　１，２，３．．．．）は物体側から数えてｉ番目の軸上面間隔（ｍｍ）を示しており、Ｎｉ　（ｉ　＝　１，２，３．．．．），νｉ（ｉ　＝　１，２，３．．．．）は物体側から数えてｉ番目の光学要素のｄ線に対する屈折率（Ｎｄ），アッベ数（νｄ）を示している。また、コンストラクションデータ中、ズーミングにおいて変化する軸上面間隔は、最短焦点距離状態（広角端、Ｗ）～中間焦点距離状態（ミドル、Ｍ）～最長焦点距離状態（望遠端、Ｔ）での可変間隔の値を示す。各焦点距離状態（Ｗ），（Ｍ），（Ｔ）に対応する全系の焦点距離（ｆ，ｍｍ）及びＦナンバー（ＦＮＯ）を他のデータと併せて示す。

【００７６】

曲率半径ｒｉに＊が付された面は、非球面で構成された面であることを示し、非球面の面形状を表す以下の式（ＡＳ）で定義されるものとする。各実施例の非球面データを他のデータと併せて示す。

【００７７】

$$Z(h)=r-(r^{2}-\varepsilon\cdot h^{2})^{1/2}+(A4\cdot H^{4}+A6\cdot H^{6}+A8\cdot H^{8}+\cdots) \qquad \text{(AS)}$$

r：非球面の近軸曲率半径、

ε：楕円係数、

Ai：非球面のi次の非球面係数、

《実施例１》

f = 5.1 - 8.9 - 14.7

Fno. = 2.16 - 3.04 - 4.10

[曲率半径]	[軸上面間隔]	[屈折率(Nd)]	[アッベ数(νd)]
r1 = 17.931			
	d1 = 1.000	N1 = 1.82302	ν1 = 36.21
r2 = 10.890			
	d2 = 3.800		
r3 = ∞			
	d3 = 12.400	N2 = 1.84666	ν2 = 23.82
r4 = ∞			
	d4 = 1.500 - 3.379 - 1.696		
r5*= -436.249			
	d5 = 1.000	N3 = 1.65461	ν3 = 46.54
r6*= 5.978			
	d6 = 1.270		
r7 = 10.014			
	d7 = 1.656	N4 = 1.84666	ν4 = 23.82
r8 = 33.402			
	d8 = 11.535 - 4.725 - 1.020		
r9 = ∞			
	d9 = 0.600		
r10= 6.649			
	d10= 6.427	N5 = 1.75450	ν5 = 51.57

r11=-7.769

d11= 1.000 N6 = 1.84666 ν6 = 23.82

r12*= 30.896

d12= 2.020 - 8.365 - 14.584

r13*= -21.319

d13= 3.778 N7 = 1.52510 ν7 = 56.38

r14= -5.800

d14= 2.804 - 1.390 - 0.560

r15=-11.316

d15= 0.800 N8 = 1.48749 ν8 = 70.44

r16= -32.669

d16= 0.100

r17= ∞

d17= 2.000 N9 = 1.51680 ν2 = 64.20

r18= ∞

[非球面係数]

r5*

ε = 0.10000000D+01

A4 = -0.95247363D-05

A6 = -0.44499878D-05

A8 = 0.20201509D-06

A10= 0.15630434D-08

r6*

ε = 0.10000000D+01

A4 = -0.44138182D-03

A6 = -0.17905680D-04

A8 = -0.12106726D-06

A10= 0.25333947D-07

r13*

ε = 0.10000000D+01

A4 = 0.11420046D-02

A6 = 0.61304067D-04

A8 = -0.24678605D-05

A10= 0.38078980D-06

r14*

ε = 0.10000000D+01

A4 = -0.17175253D-02

A6 = 0.35415900D-04

A8 = -0.51967472D-05

A10= 0.10804669D-06

《実施例２》

f = 5.1 - 8.9 - 14.7

Fno.= 2.16 - 2.97 - 4.10

[曲率半径]	[軸上面間隔]	[屈折率(Nd)]	[アッベ数(νd)]
r1* = 77.048			
	d1 = 1.000	N1 = 1.66602	ν1 = 30.12
r2 = 10.412			
	d2 = 3.701		
r3 = ∞			
	d3 = 12.400	N2 = 1.84666	ν2 = 23.82
r4 = ∞			
	d4 = 0.200		
r5 = 12.063			

d5 = 1.645 N3 = 1.84898 ν3 = 33.15

r6 = 22.797

d6 = 2.045 - 5.298 - 3.490

r7*= 74.513

d7 = 1.000 N4 = 1.52510 ν4 = 56.38

r8*= 6.297

d8 = 1.041

r9 = 7.766

d9 = 1.464 N5 = 1.79850 ν5 = 22.6

r10= 10.311

d10= 13.841 - 5.438 - 1.000

r11= ∞

d11= 0.600

r12= 6.616

d12= 5.892 N6 = 1.75450 ν6 = 51.57

r13= -10.215

d13= 1.000 N7 = 1.84666 ν7 = 23.82

r14*= 18.124

d14= 2.079 - 8.055 - 15.451

r15*=-23.464

d15= 3.400 N8 = 1.52510 ν8 = 56.82

r16 =-6.333

d16= 2.476 - 1.650 - 0.500

r17 = 14.316

d17= 1.000 N9 = 1.84833 ν9 = 29.89

r18= 10.360

d18= 0.907

r19= ∞

d19= 2.000 N10= 1.51680 ν10= 64.20

r20= ∞

[非球面係数]

r1*

ε = 0.10000000E+01

A4 = 0.63638407E-04

A6 = -0.36516691E-06

A8 = 0.15861666E-08

r7*

ε = 0.10000000E+01

A4= -0.63173747E-03

A6= 0.42880271E-04

A8 = -0.13655536E-05

A10= 0.17341485E-07

r8*

ε = 0.10000000E+01

A4 = -0.78352207E-03

A6 = 0.45124782E-04

A8 = -0.17639048E-05

A10= 0.22553499E-07

r15*

ε = 0.10000000E+01

A4 = 0.10864595E-02

A6 = 0.63616957E-04

A8 = -0.36734216E-05

A10= 0.41688467E-06

r16*

ε = 0.10000000E+01

A4 = -0.14356439E-02

A6 = 0.25426605E-04

A8 = -0.32121190E-05

A10= 0.95302924E-07

《実施例3》

f = 4.5 - 7.9 - 12.9

Fno.= 2.1 - 2.8 - 3.7

[曲率半径]	[軸上面間隔]	[屈折率(Nd)]	[アッベ数(νd)]
r1 = 4101.218			
	d1 = 0.700	N1 = 1.78589	ν1 = 44.20
r2 = 19.552			
	d2 = 0.900		
r3 = ∞			
	d3 = 8.000	N2 = 1.84666	ν2 = 23.82
r4 = ∞			
	d4 = 1.000 - 3.596 - 1.000		
r5*= 56.521			
	d5 = 0.800	N3 = 1.57501	ν3 = 41.49
r6*= 4.357			
	d6 = 1.021		
r7 = 7.895			
	d7 = 1.6000	N4 = 1.84666	ν4 = 23.82
r8 = 21.921			
	d8 = 10.752 - 3.530 - 0.969		
r9 = ∞			

d9 = 0.650

r10=5.274

d10= 4.755 N5 = 1.75450 ν5 = 51.57

r11=-9.977

d11= 0.010 N6 = 1.51400 ν6 = 42.83

r12=-9.977

d12= 0.800 N7 = 1.84666 ν7 = 23.82

r13*=15.094

d13= 2.179 - 7.261 - 12.815

r14*=-25.000

d14= 3.200 N8 = 1.52510 ν8 = 56.38

r15*= -5.767

d15= 1.453 - 0.996 - 0.600

r16= 10.099

d16= 0.983 N9 = 1.70055 ν9 = 30.11

r17= 6.767

d17= 0.948

r18= ∞

d18= 1.500 N10= 1.51680 ν10= 64.20

r19= ∞

[非球面係数]

r5*

ε = 0.10000000E+01

A4 = -0.44053024E-03

A6 = -0.45582866E-04

A8 = 0.56807258E-05

A10= -0.21748168E-06

r6*

ε = 0.10000000E+01

A4 = -0.19077667E-02

A6 = -0.45431102E-04

A8 = -0.17609821E-05

A10= -0.26911785E-08

r13*

ε = 0.10000000E+01

A4 = 0.24256912E-02

A6 = 0.13113475E-03

A8 = -0.19935678E-05

A10= 0.20427432E-05

r14*

ε = 0.10000000E+01

A4 = -0.76241384E-03

A6 = -0.45684352E-04

A8 = 0.74367662E-05

A10= 0.17395830E-06

r15*

ε = 0.10000000E+01

A4 = 0.16617833E-02

A6 = -0.97370809E-04

A8 = 0.83998804E-05

《実施例４》

f = 4.5 - 7.6 - 12.9

Fno.= 2.1 - 2.8 - 2.97

[曲率半径]	[軸上面間隔]	[屈折率(Nd)]	[アッベ数(νd)]
r1 = -25.000			
	d1 = 0.800	N1 = 1.63980	ν1 = 34.55
r2 =-115.843			
	d2 = 0.100		
r3 = ∞			
	d3 = 9.200	N2 = 1.84666	ν2 = 23.82
r4 = ∞			
	d4 = 1.000 - 4.551 - 2.772		
r5*= 21.359			
	d5 = 0.800	N3 = 1.83400	ν3 = 37.15
r6*= 5.824			
	d6 = 3.352		
r7 = 14.337			
	d7 = 1.500	N4 = 1.84666	ν4 = 23.82
r8 = 52.503			
	d8 = 12.765 - 4.785 - 0.910		
r9 = ∞			
	d9 = 0.700		
r10= 12.888			
	d10= 2.200	N5 = 1.75450	ν5 = 51.57
r11= -36.914			
	d11= 0.100		
r12= 4.598			
	d12= 3.800	N6 = 1.48749	ν6 = 70.44
r13= 181.628			
	d13= 0.010	N7 = 1.51400	ν7 = 42.83
r13= 181.628			

d14 = 1.000　　N8 = 1.84666　　ν8 = 23.82

r15*= 3.955

d15= 1.500 - 6.298 - 12.506

r16* = 10.062

d16= 2.000　　N9 = 1.48749　　ν9 = 70.44

r17*=-8.840

d17= 1.472 - 1.104 - 0.600

r18= ∞

d18= 1.700　　N10= 1.51680　　ν10= 64.20

r19= ∞

[非球面係数]

r5*

ε = 0.10000000E+01

A4 = 0.28920160E-03

A6 = -0.24770223E-04

A8 = 0.40226114E-06

r6*

ε = 0.10000000E+01

A4 = -0.28416506E-03

A6 = -0.39127534E-04

A8 = 0.10049102E-06

r15*

ε = 0.10000000E+01

A4 = 0.22971891E-02

A6 = 0.61362182E-04

A8 = 0.38054044E-04

r16*
ε = 0.10000000E+01
A4 = 0.29657551E-02
A6 = -0.32988137E-03
A8 = 0.18146796E-04
r17*
ε = 0.10000000E+01
A4 = 0.65616586E-02
A6 = -0.68518707E-03
A8 = 0.33543925E-04

《実施例５》
f = 4.5 - 7.9 - 12.9
Fno.= 2.1 - 2.89 - 3.8

[曲率半径]	[軸上面間隔]	[屈折率(Nd)]	[アッベ数(νd)]
r1 = 16.688			
	d1 = 0.800	N1 = 1.54072	ν1 = 47.22
r2 = 7.343			
	d2 = 2.500		
r3 = ∞			
	d3 = 8.400	N2 = 1.84666	ν2 = 23.82
r4 = ∞			
	d4 = 1.500 - 2.971 - 1.500		
r5*=164.473			
	d5 = 0.800	N3 = 1.62004	ν3 = 36.26
r6*= 4.995			
	d6 = 1.353		
r7 =10.132			

d7 = 2.267 N4 = 1.84666 ν4 = 23.82

r8 = 69.912

d8 = 11.101 - 4.724 - 0.862

r9 = ∞

d9 = 0.650

r10= 5.681

d10= 5.504 N5 = 1.75450 ν5 = 51.57

r11= -10.007

d11= 0.010 N6 = 1.51400 ν6 = 42.83

r12 =-10.007

d12= 0.800 N7 = 1.84666 ν7 = 23.82

r13*= 13.518

d13= 1.987 - 8.774 - 14.499

r14*= 72.616

d14= 3.700 N8 = 1.52510 ν8 = 56.38

r15*=-8.793

d15= 3.078 - 1.197 - 0.806

r16= ∞

d16= 1.500 N9 = 1.51680 ν9 = 64.20

[非球面係数]

r5*

ε = 0.10000000E+01

A4 = -0.50212557E-03

A6 = 0.58262738E-04

A8 = -0.45960476E-05

A10= 0.10745067E-06

r6*

ε = 0.10000000E+01
A4 = -0.17341477E-02
A6 = 0.76117570E-04
A8 = -0.99234139E-05
A10= 0.25780579E-06

r13*
ε = 0.10000000E+01
A4 = 0.22365769E-02
A6 = 0.79579971E-04
A8 = 0.53500363E-05
A10= 0.10651891E-05

r14*
ε = 0.10000000E+01
A4 = -0.74920577E-03
A6 = -0.44003627E-04
A8 = -0.46232075E-05
A10= 0.52351697E-06

r15*
ε = 0.10000000E+01
A4 = 0.27419718E-03
A6 = -0.15545535E-03
A8 = 0.68734468E-05

《実施例６》
f = 5.1 - 8.9 - 14.7
Fno.= 2.24 - 2.98 - 4.10

[曲率半径]	[軸上面間隔]	[屈折率(Nd)]	[アッベ数(νd)]
r1* = 17.487			
	d1 = 1.000	N1 = 1.733922	ν1 = 29.35
r2 = 10.704			
	d2 = 3.877		
r3 = ∞			
	d3 =12.400	N2 = 1.84666	ν2 = 23.82
r4 = ∞			
	d4 = 1.500		
r5*= 213.855			
	d5 = 1.000	N3 = 1.61203	ν3 = 52.33
r6*= 5.360			
	d6 = 1.317		
r7 = 9.257			
	d7 = 1.649	N4 = 1.84666	ν4 = 23.82
r8 = 23.872			
	d8 = 12.037 - 4.771 - 1.000		
r9 = ∞			
	d9 = 0.600		
r10= 6.464			
	d10= 6.219	N5 = 1.75450	ν5 = 51.57
r11=-7.306			
	d11= 1.000	N6 = 1.84666	ν6 = 23.82
r12*= 33.980			
	d12= 2.038 - 7.101 - 13.534		
r13*= -17.735			
	d13= 3.475	N7 = 1.52510	ν7 = 56.38
r14= -5.800			
	d14= 2.546 - 1.749 - 0.500		

r15= -10.504
d15= 1.000 N8 = 1.48749 ν8 = 70.44
r16= -32.714
d16= 0.109
r17= ∞
d17= 2.000 N9 = 1.51680 ν9 = 64.20
r18= ∞

[非球面係数]

r5*
ε = 0.10000000E+01
A4 = -0.17088362E-03
A6 = -0.59468528E-06
A8 = 0.17670065E-06
A10= -0.21232398E-09

r6*
ε = 0.10000000E+01
A4 = -0.78520204E-03
A6 = -0.18852025E-04
A8 = -0.22264586E-06
A10= 0.62844746E-08

r13*

ε = 0.10000000E+01

A4 = 0.12126439E-02

A6 = 0.68930495E-04

A8 = -0.29394404E-05

A10= 0.46789735E-06

r14*

ε = 0.10000000E+01

A4 = -0.16889906E-02

A6 = 0.41032113E-04

A8 = -0.67973071E-05

A10= 0.22276351E-06

《実施例7》

f = 5.8 - 11.6 - 16.7

Fno.= 3.60 - 3.60 - 3.66

[曲率半径]	[軸上面間隔]	[屈折率(Nd)]	[アッベ数(νd)]
r1* =-11.725			
	d1 = 1.200	N1 = 1.49310	ν1 = 83.58
r2* = 13.872			
	d2 = 1.410		
r3 = ∞			
	d3 = 7.000	N2 = 1.84666	ν2 = 23.82
r4 = ∞			
	d4 = 22.033 - 8.278 - 0.600		
r5 = 6.671			
	d5 = 2.562	N3 = 1.75450	ν3 = 51.57
r6 = 35.072			

d6 = 0.600

r7 = ∞

d7 = 0.600

r8* = 18.236

d8 = 0.800 N4 = 1.84666 ν4 = 23.82

r9* = 8.198

d9 = 7.034 - 16.244 - 14.414

r10 = 39.487

d10 = 2.334 N5 = 1.49310 ν5 = 83.58

r11 = -13.184

d11 = 3.125 - 7.669 - 17.177

r12 = 21.757

d12 = 0.800 N6 = 1.84666 ν6 = 23.82

r13 = 9.428

d13 = 0.175

r14 = 10.828

d14 = 2.272 N7 = 1.50467 ν7 = 59.44

r15* = -70.639

d15 = 1.665

r16 = ∞

d16 = 2.000 N8 = 1.51680 ν8 = 64.20

r17 = ∞

[非球面係数]

r1*

ε = 0.10000E+01

A4 = 0.39770E-03

A6 = 0.48251E-05

A8 = -0.13574E-06

A10= 0.82447E-09

r2*

ε = 0.10000E+01

A4 = 0.12088E-03

A6 = 0.37656E-05

A8 = 0.23199E-06

A10= -0.73492E-08

r8*

ε = 0.10000E+01

A4 = 0.53711E-03

A6 = 0.22090E-04

A8 = -0.48503E-05

A10= 0.21033E-06

r9*

ε = 0.10000E+01

A4 = 0.14617E-02

A6 = 0.84785E-04

A8 = -0.97230E-05

A10= 0.62378E-06

r15*

ε = 0.10000E+01

A4 = 0.11315E-02

A6 = -0.58783E-04

A8 = 0.63291E-05

A10= -0.18581E-06

《実施例８》

f = 6.0 - 12.0 - 17.3

Fno.= 3.60 - 3.60 - 3.60

[曲率半径]	[軸上面間隔]	[屈折率(Nd)]	[アッベ数(νd)]
r1* =-72.486			
	d1 = 1.200	N1 = 1.49310	ν1 = 83.58
r2* = 8.054			
	d2 = 2.476		
r3 = ∞			
	d3 = 9.000	N2 = 1.84666	ν2 = 23.82
r4 = ∞			
	d4 = 21.244 - 4.060 - 0.600		
r5 = 6.766			
	d5 = 2.652	N3 = 1.79719	ν3 = 45.34
r6 = 17.430			
	d6 = 1.000		
r7 = ∞			
	d7 = 0.686		
r8* = 93.830			
	d8 = 0.800	N4 = 1.84666	ν4 = 23.82
r9* = 12.440			
	d9 = 3.714 - 12.381 - 9.898		
r10 = 22.538			
	d10 = 2.473	N5 = 1.49310	ν5 = 83.58
r11 = -15.873			
	d11 = 1.500 - 9.644 - 21.642		
r12 = -11.841			
	d12 = 0.800	N6 = 1.84666	ν6 = 23.82

r13 = -27.408

d13 = 0.100

r14 = 16.037

d14 = 2.349 N7 = 1.72904 ν7 = 52.47

r15* = -57.477

d15 = 6.683 - 7.055 - 1.000

r16 = ∞

d16 = 2.000 N8 = 1.51680 ν8 = 64.20

r17 = ∞

[非球面係数]

r1*

ε = 0.10000E+01

A4 = -0.24017E-05

A6 = 0.29455E-05

A8 = -0.30412E-07

A10= 0.12502E-10

r2*

ε = 0.10000E+01

A4 = -0.18797E-03

A6 = -0.38877E-05

A8 = 0.34374E-06

A10= -0.63589E-08

r8*

ε = 0.10000E+01

A4 = 0.58124E-03

A6 = 0.33012E-04

A8 = -0.45331E-05
A10= 0.17297E-06

r9*
ε = 0.10000E+01
A4 = 0.13667E-02
A6 = 0.79666E-04
A8 = -0.97230E-05
A10= -0.77035E-05

r15*
ε = 0.10000E+01
A4 = 0.63869E-04
A6 = -0.71764E-04
A8 = 0.36999E-05
A10= -0.66315E-06

《実施例９》
f = 5.8 - 11.6 - 16.7
Fno.= 3.60 - 3.60 - 3.60

[曲率半径]	[軸上面間隔]	[屈折率(Nd)]	[アッベ数(νd)]
r1* =-14.542			
	d1 = 1.200	N1 = 1.49310	ν1 = 83.58
r2* = 12.397			
	d2 = 1.494		
r3 = ∞			
	d3 = 7.000	N2 = 1.84666	ν2 = 23.82
r4 = ∞			
	d4 = 22.039 - 8.570 - 0.600		

r5* = 7.238

d5 = 2.651 N3 = 1.71300 ν3 = 53.93

r6 = 48.781

d6 = 0.677

r7 = ∞

d7 = 0.600 - 0.931 - 1.000

r8* = 25.723

d8 = 0.805 N4 = 1.84666 ν4 = 23.82

r9* = 10.714

d9 = 6.475 - 16.205 - 14.774

r10 = 42.281

d10 = 2.322 N5 = 1.49310 ν5 = 83.58

r11 = -13.537

d11 = 4.243 - 7.651 - 16.983

r12 = 19.872

d12 = 0.800 N6 = 1.84666 ν6 = 23.82

r13 = 8.858

d13 = 0.100

r14 = 6.329

d14 = 2.301 N7 = 1.48749 ν7 = 70.44

r15* = 16.784

d15 = 0.996

r16 = ∞

d16 = 2.000 N8 = 1.51680 ν2 = 64.20

r17 = ∞

[非球面係数]

r1*

ε = 0.10000E+01

A4 = 0.31440E-03

A6 = 0.40741E-05

A8 = -0.13254E-06

A10= 0.88372E-09

r2*

ε = 0.10000E+01

A4 = -0.14549E-03

A6 = 0.90366E-05

A8 = 0.23593E-06

A10= -0.68590E-08

r8*

ε = 0.10000E+01

A4 = 0.60518E-03

A6 = 0.22274E-04

A8 = -0.54357E-05

A10= 0.24817E-06

r9*

ε = 0.10000E+01

A4 = 0.13444E-02

A6 = 0.68972E-04

A8 = -0.94129E-05

A10= -0.53475E-06

r15*

ε = 0.10000E+01

A4 = 0.12639E-02

A6 = -0.11077E-04

A8 = 0.48956E-05

A10= -0.16001E-06

図１０乃至図１８は実施例１～実施例９の収差図であり、各実施例のズームレンズ系の無限遠合焦状態での収差を表している。図１０乃至図１８中、（Ｗ）は最短焦点距離状態、

（Ｍ）は中間焦点距離状態、（Ｔ）は最長焦点距離状態における諸収差｛左から順に、球面収差等、非点収差、歪曲収差、Ｙ’（ｍｍ）は撮像素子上での最大像高（光軸からの距離に相当）｝を示している。球面収差図において、実線（ｄ）はｄ線に対する球面収差、一点鎖線（ｇ）はｇ線に対する球面収差、二点鎖線（ｃ）はｃ線に対する球面収差、破線（ＳＣ）は正弦条件を表している。非点収差図において、破線（ＤＭ）はメリディオナル面での非点収差、実線（ＤＳ）はサジタル面での非点収差を表している。また、歪曲収差図において、実線はｄ線に対する歪曲％を表している。

【００７８】

【発明の効果】

以上説明したように、各実施形態のズームレンズ系によれば、高性能で高倍率ズームレンズ系を備えながら、コンパクトな、撮像装置を提供することができる。

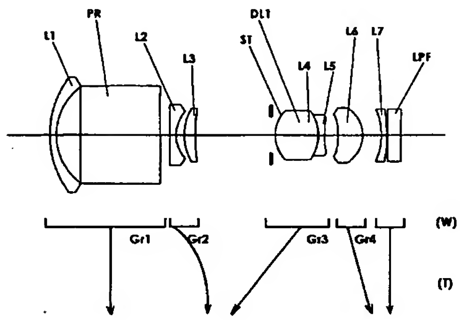
【図面の簡単な説明】

【図１】第１の実施形態（実施例１）のレンズ構成図。
【図２】第２の実施形態（実施例２）のレンズ構成図。
【図３】第３の実施形態（実施例３）のレンズ構成図。
【図４】第４の実施形態（実施例４）のレンズ構成図。
【図５】第５の実施形態（実施例１）のレンズ構成図。
【図６】第６の実施形態（実施例２）のレンズ構成図。
【図７】第７の実施形態（実施例３）のレンズ構成図。
【図８】第８の実施形態（実施例４）のレンズ構成図。
【図９】第９の実施形態（実施例４）のレンズ構成図。
【図１０】実施例１の無限遠合焦状態での収差図。
【図１１】実施例２の無限遠合焦状態での収差図。
【図１２】実施例３の無限遠合焦状態での収差図。
【図１３】実施例４の無限遠合焦状態での収差図。
【図１４】実施例５の無限遠合焦状態での収差図。
【図１５】実施例６の無限遠合焦状態での収差図。
【図１６】実施例７の無限遠合焦状態での収差図。
【図１７】実施例８の無限遠合焦状態での収差図。
【図１８】実施例９の無限遠合焦状態での収差図。
【図１９】本発明の概略を示す構成図。

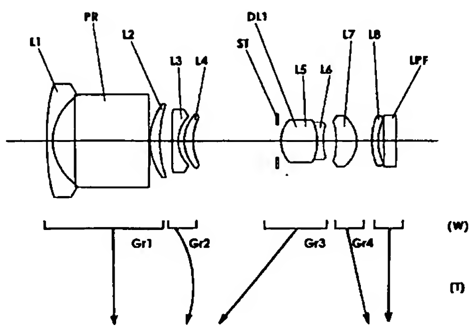
【符号の説明】

ＬＰＦ：光学的ローパスフィルタに相当する平行平面板
ＳＲ：撮像素子
ＴＬ：ズームレンズ系
Ｇｒ１：第１レンズ群Ｇｒ１
Ｇｒ２：第２レンズ群Ｇｒ２
ＰＲ：内面反射プリズム
ＳＴ：絞り

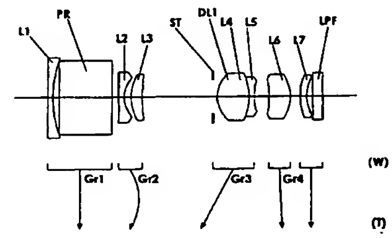
【図１】



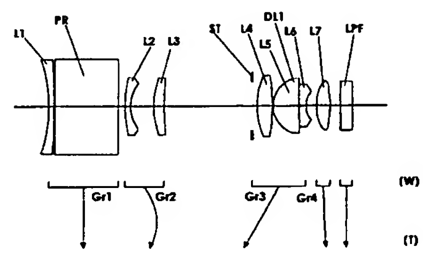
【図２】



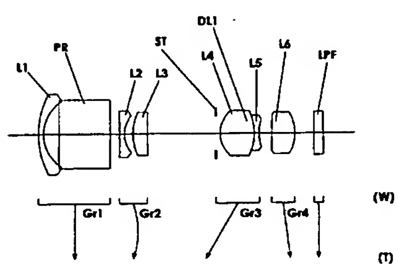
【図３】



【図４】



【図５】



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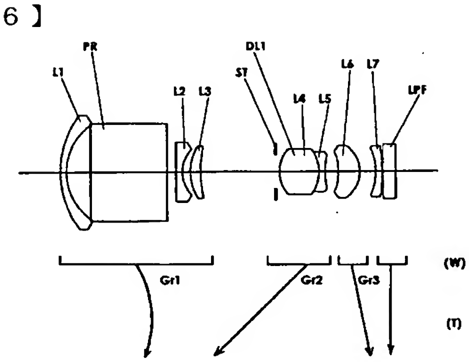

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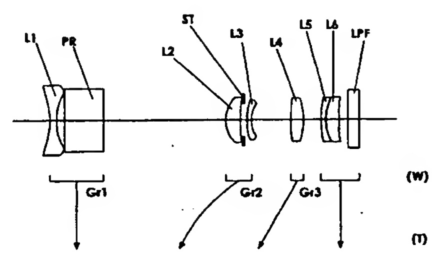
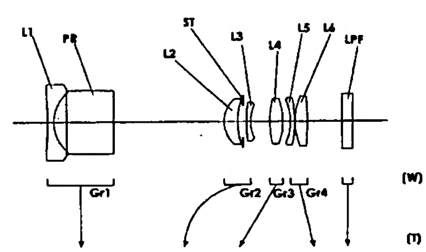
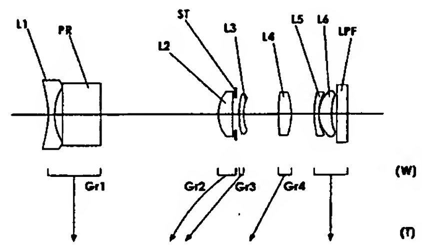


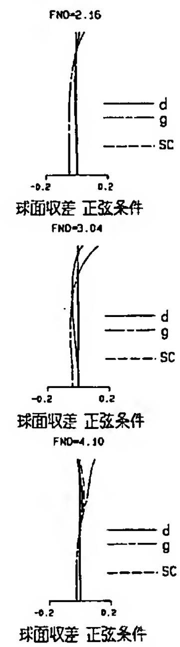
【図８】



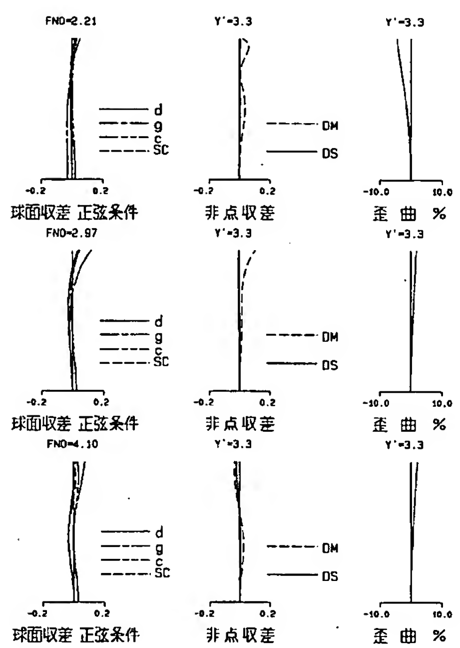
【図９】



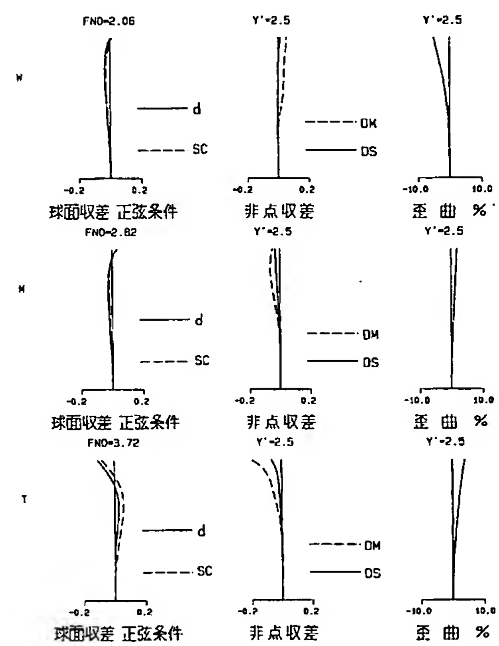
【図１０】



【図１１】



【図１２】



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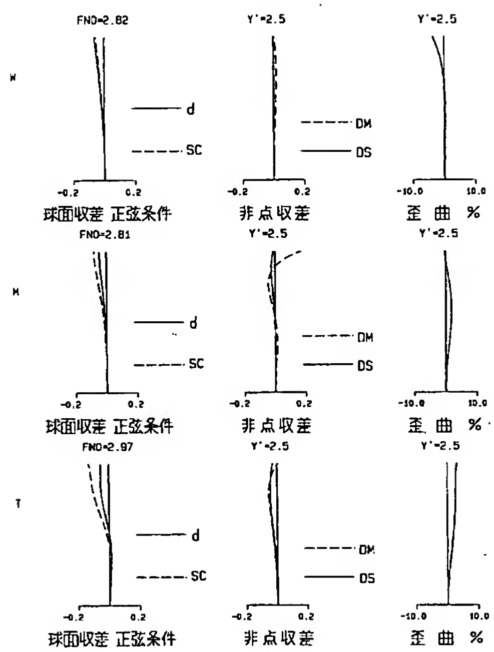
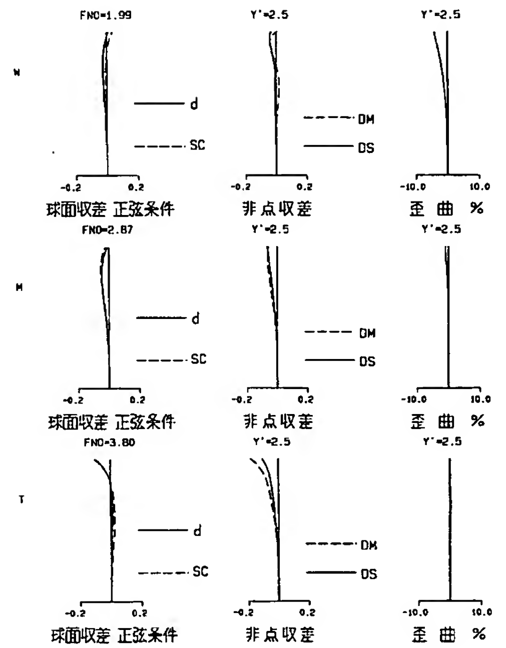


【図１４】



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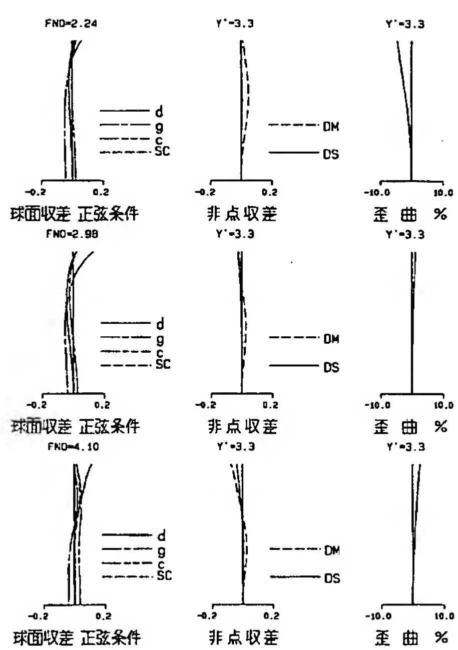

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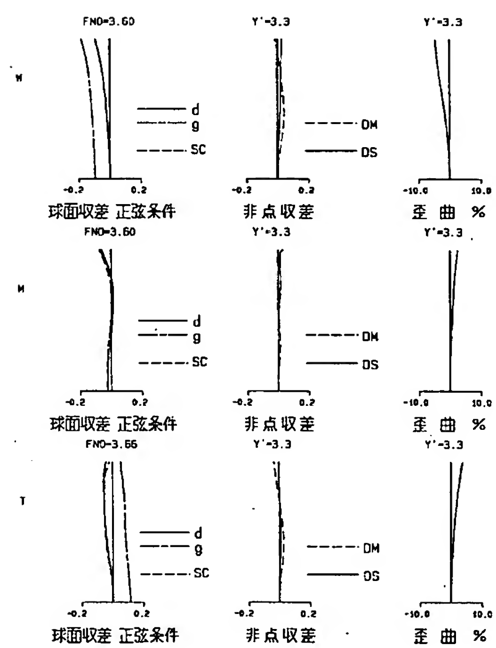

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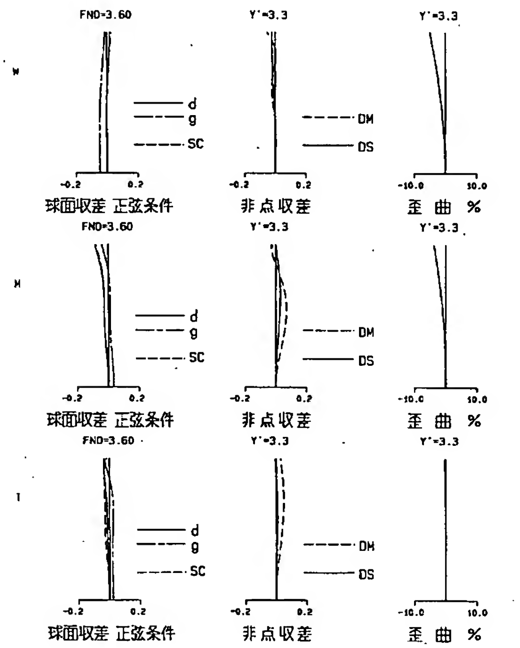
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SC
DM
DS
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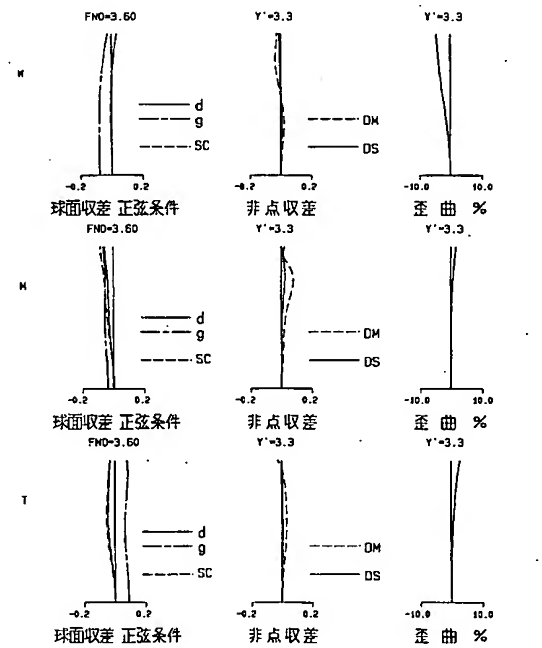
10.0
球面収差 正弦条件
非点収差
歪 曲 %
M
T

【図１８】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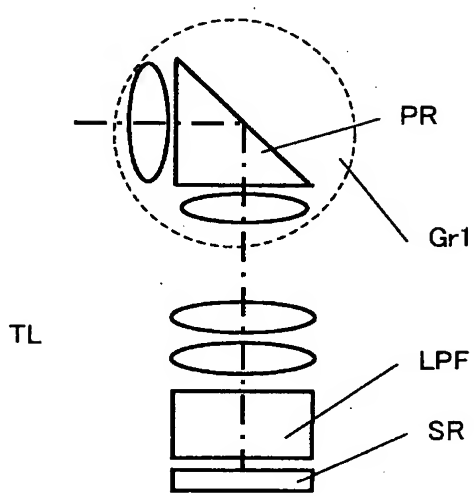
球面収差 正弦条件
非点収差
歪 曲 %
M
T

【図１９】


PR
Gr1
TL
LPF
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(51)Int.Cl.⁷	F I	テーマコード（参考）
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Ｆターム(参考) 2H083 AA09 AA26
2H087 KA01 PA05 PA06 PA18 PB06 PB07 QA02 QA06 QA07 QA17
RA05 RA12 RA13 RA36 RA41 RA42 RA43 SA41 SA44 SA45
SA48 SA51 SA54 SA63 SA64 SA65 SA72 SB02 SB03 SB04
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5C022 AA13 AB66 AC42 AC54 AC55